UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES, AND
TOXIC SUBSTANCES

MEMORANDUM

DATE: 16-NOV-2006

SUBJECT **Registration of Fludioxonil (Scholar SC™, EPA Registration #100-xxx) for Postharvest Use on Stone Fruit, Citrus Fruit, Pome Fruit, Kiwi, & Yam.** MRID#s 46715501 thru -06. DP# 325160. PC Code 071503. Decision# 352160.

FROM: George F. Kramer, Ph.D., Senior Chemist
Registration Action Branch 1 (RAB1)
Health Effects Division (HED) (7509P)

THROUGH: P.V. Shah, Ph.D., Branch Senior Scientist
RAB1/HED (7509P)

TO: Lisa Jones/Mary Waller, RM 21
Registration Division (RD) (7505P)

Fludioxonil is a contact fungicide, which inhibits protein kinase, leading to reduced fungal growth and development. Tolerances are currently established for residues of fludioxonil, 4-(2,2-difluoro-1,3-benzodioxol-4-yl)-1*H*-pyrrole-3-carbonitrile, in/on various plant commodities at levels ranging from 0.01-500 ppm [40 CFR §180.516], including the citrus fruit crop group (10 ppm), pome fruits crop group (5.0 ppm), kiwi fruit (20 ppm), yam (8.0 ppm), and stone fruit crop group (5.0 ppm). Scholar™ 50 WP, a wettable powder consisting of 50% fludioxonil is currently registered for postharvest use on kiwi, citrus fruit, pome fruit, and stone fruit. Syngenta is now proposing to register a 1.9 lb/gal suspension-concentrate (SC) formulation (Scholar SC™, EPA Registration #100-xxx) for postharvest use on these crops.

CONCLUSIONS/RECOMMENDATIONS

As the formulation type had no consistent effect on fludioxonil residues, HED recommends in favor of registration of the proposed SC formulation. The maximum observed residues in peaches (5.5 ppm) exceeds the established tolerance of 5.0 ppm for stone fruit. HED thus recommends that RD requires the registrant to petition the Agency for an increased tolerance for stone fruit.

DETAILED CONSIDERATIONS

Proposed Use: The currently registered uses Scholar™ 50 WP are summarized in Table 1.

Table 1. Currently registered uses Scholar™ 50 WP

Crop	Application Type	Rate	# Applications	Comments
Stone Fruit	High-Volume Spray	0.25 to 0.5 lb ai in 25-100 gallons of water	1	To treat 200,000lbs of apricots, nectarines, peaches, plums, or 25,000 lbs. of cherries.
	Low-Volume Spray	0.25 to 0.5 lb ai in 7-25 gallons of water	1	To treat 200,000lbs of apricots, nectarines, peaches, plums, or 25,000 lbs. of cherries.
	Dip	0.25 to 0.5 lb ai in 100 gallons of water	1	Dip for ~30 sec.
Citrus Fruit	High-Volume Spray	0.5 to 1.0 lb ai in 25-100 gallons of water	2	
	Low-Volume Spray	0.5 to 1.0 lb ai in 7-25 gallons of water	2	To treat 250,000lbs of fruit
	Dip	0.5 to 1.0 lb ai in 100 gallons of water	2	Dip for ~30 sec.
Pome Fruit	High-Volume Spray	0.25 to 0.5 lb ai in 25-100 gallons of water	2	
	Low-Volume Spray	0.25 to 0.5 lb ai in 7-25 gallons of water	2	To treat 200,000lbs of fruit
	Dip	0.25 to 0.5 lb ai in 100 gallons of water	2	Dip for ~30 sec.
Kiwi	Low-Volume Spray	0.25 to 0.5 lb ai in 7-25 gallons of water	1	To treat 200,000lbs of fruit
	Dip	0.25 to 0.5 lb ai in 100 gallons of water	1	Dip for ~30 sec.
Yam	Dip	0.25 to 0.5 lb ai in 100 gallons of water	1	Dip for ~30 sec.

Syngenta is now proposing to register Scholar SC™ (EPA Registration #100-xxx), a 1.9 lb/gal SC formulation, with the same pattern as Scholar™ 50 WP.

Residue Data: Syngenta has submitted six volumes of residue data containing side-by-side trials

with the WP and SC formulations (MRID#s 46715501 thru -06).

Orange and Grapefruit (MRID# 46715501):

TABLE 2. Summary of Residue Data from Post-harvest Grapefruit Trials with Fludioxonil (SC or WP).										
Commodity	Treatment type (formulation)	PTI[3] (days)	Total Rate (lb ai)[1]	Residue Levels (ppm)[2]						
				n	Min.	Max.	HAFT[3]	Median	Mean	Std. Dev.
Whole fruit	Dip (1.9 lb/gal SC)	0	0.5	4	0.60	0.95	0.87	0.75	0.76	0.15
Peeled fruit				4	<0.02	0.05	0.05	0.03	0.03	0.02
Whole fruit	Low volume (1.9 lb/gal SC)	0	0.5	4	0.07	0.67	0.67	0.41	0.39	0.32
Peeled fruit				4	<0.02	0.04	0.04	0.02	0.02	0.02
Washed fruit				4	<0.02	0.38	0.32	0.13	0.16	0.18
Whole fruit	Drench + LV (1.9 lb/gal SC)	0	0.5	4	0.14	0.34	0.30	0.25	0.25	0.08
Peeled fruit				4	<0.02	0.03	0.02	0.01	0.02	0.01
Washed fruit				4	0.16	0.29	0.23	0.22	0.22	0.05
Whole fruit	Drench + LV (1.9 lb/gal SC)	0	1.0	4	0.17	0.59	0.53	0.33	0.36	0.21
Peeled fruit				4	<0.02	0.03	0.03	0.02	0.02	0.01
Washed fruit				4	0.13	0.43	0.43	0.29	0.28	0.17
Whole fruit	Low volume (50% WP)	0	0.5	4	0.05	0.92	0.91	0.49	0.49	0.49
Peeled fruit				4	<0.02	0.04	0.04	0.02	0.02	0.02
Whole fruit	Low volume (50% WP)	0	1.0	2	1.50	1.50	1.50	1.50	1.50	0.00
Peeled fruit				2	0.09	0.09	0.09	0.09	0.09	0.00
Washed fruit				2	0.52	0.58	0.55	0.55	0.55	0.04

[1] Application rates are expressed in lb ai/100 gallons for dip and drench type applications and in lb ai/ 250,000 lb fruit for the low-volume (LV) type application.

[2] The validated method LOQ is 0.02 ppm for fludioxonil. For calculation of the median, mean and standard deviation, ½LOQ (0.01 ppm) was used for samples with residues <LOQ.

[3] PTI = Post-treatment interval, HAFT = Highest-Average Field Trial.

TABLE 3. Summary of Residue Data from Post-harvest Orange Trials with Fludioxonil (SC or WP).										
Commodity	Treatment type (formulation)	PTI[3] (days)	Total Rate (lb ai)[1]	Residue Levels (ppm)[2]						
				n	Min.	Max.	HAFT[3]	Median	Mean	Std. Dev.
Whole fruit	Dip (1.9 lb/gal SC)	0	0.5	4	0.70	1.10	0.98	0.93	0.91	0.18
Peeled fruit				4	0.05	0.08	0.07	0.07	0.07	0.02
Whole fruit	Low volume (1.9 lb/gal SC)	0	0.5	4	0.37	0.74	0.66	0.54	0.55	0.15
Peeled fruit				4	<0.02	0.07	0.06	0.03	0.04	0.03
Washed fruit				4	0.07	1.10	0.59	0.31	0.45	0.45
Whole fruit	Drench + LV (1.9 lb/gal SC)	0	0.5	4	0.32	0.53	0.46	0.36	0.39	0.10
Peeled fruit				4	<0.02	0.05	0.05	0.03	0.03	0.02
Washed fruit				4	0.13	0.21	0.20	0.17	0.17	0.03
Whole fruit	Drench + LV (1.9 lb/gal SC)	0	1.0	4	0.75	0.86	0.85	0.81	0.81	0.05
Peeled fruit				4	0.03	0.06	0.05	0.04	0.04	0.01
Washed fruit				4	0.16	0.47	0.43	0.29	0.30	0.15
Whole fruit	Low volume (50% WP)	0	0.5	4	0.62	0.85	0.74	0.73	0.73	0.12
Peeled fruit				4	0.03	0.08	0.08	0.07	0.06	0.02
Whole fruit	Low volume (50% WP)	0	1.0	2	0.90	1.00	0.95	0.95	0.95	0.07
Peeled fruit				2	0.05	0.11	0.08	0.08	0.08	0.04
Washed fruit				2	0.06	0.19	0.13	0.13	0.13	0.09

[1] Application rates are expressed in lb ai/100 gallons for dip and drench type applications and in lb ai/ 250,000 lb fruit for the low-volume (LV) type application.

[2] The validated method LOQ is 0.02 ppm for fludioxonil. For calculation of the median, mean and standard deviation, ½LOQ (0.01 ppm) was used for samples with residues <LOQ.

[3] PTI = Post-treatment interval, HAFT = Highest-Average Field Trial.

Lemon (MRID# 46715502):

TABLE 4. Summary of Residue Data from Lemon Post-harvest Trials with Fludioxonil (SC or WP).										
Trt	Commodity	PTI[3] (days)	Total Rate (lb ai)[1]	Residue Levels (ppm)[2]						
				n	Min.	Max.	HAFT[3]	Median	Mean	Std. Dev.
SC Drench	Fruit	0	0.5-0.6	4	0.80	1.20	1.10	0.95	0.97	0.17
	Washed Fruit			4	0.49	0.87	0.85	0.71	0.69	0.19
SC Drench + LV[4]	Fruit	0	1.0-1.6	6	1.90	3.90	3.45	3.10	2.93	0.70
SC Drench + LV[5]	Fruit	0	1.0-1.1	4	1.20	1.30	1.30	1.30	1.28	0.05
SC LV	Fruit	0	0.5-1.0	6	0.93	1.70	1.65	1.15	1.25	0.33
	Washed Fruit			6	0.04	0.58	0.54	0.39	0.36	0.20
SC 2 Drench + LV	Fruit	0	1.3-1.4	6	1.10	2.80	2.60	1.90	1.90	0.65
WP Drench	Fruit	0	0.5	4	0.80	1.10	1.01	0.93	0.94	0.12
	Washed Fruit			4	0.46	0.55	0.54	0.54	0.52	0.04
WP Drench + LV[4]	Fruit	0	1.0-1.5	4	2.00	2.50	2.25	2.10	2.18	0.22
WP Drench + LV[5]	Fruit	0	1.0	4	1.30	1.70	1.65	1.55	1.53	0.17

[1] Rates are expressed in lb ai/100 gallons for the drench applications and in lb ai/250,000 fruit for the low-volume application.
[2] The LOQ is 0.02 ppm.
[3] PTI = Post-treatment interval, HAFT = Highest-Average Field Trial.
[4] Drench application at 0.5-0.6 lb ai/100 gal followed immediately by a low-volume application.
[5] Drench application at 0.5-0.6 lb ai/100 gal followed by 14 days of refrigerated storage and then a low-volume application.

Pome Fruit (MRID# 46715503):

TABLE 5. Summary of Residue Data from Post-harvest Pome Fruit Trials with Fludioxonil (SC or WP).										
Commodity	Application (formulation)	PTI[3] (days)	Total Rate (lb ai)[1]	Residue Levels (ppm)[2]						
				n	Min.	Max.	HAFT[3]	Median	Mean	Std. Dev.
Apple	Drench application (SC)	0	0.25	8	0.26	1.60	1.17	0.72	0.81	0.46
	Low-volume application (SC)		0.25	8	0.06	1.00	0.87	0.14	0.33	0.36
	Drench + wash + low-volume application (SC)		0.50	8	0.42	2.30	2.25	0.56	1.04	0.80
	Drench + wash + low-volume application (WP)		0.50	4	0.39	0.73	0.60	0.48	0.52	0.15
	Low-volume application (WP)		0.50	4	0.05	0.51	0.28	0.10	0.19	0.22
Pear	Drench application (SC)	0	0.25	8	0.02	1.20	0.65	0.45	0.50	0.39
	Low-volume application (SC)		0.25	8	0.11	1.40	1.35	0.54	0.63	0.53
	Drench + wash + low-volume application (SC)		0.50	8	0.39	2.90	1.80	0.91	1.23	0.89
	Drench + wash + low-volume application (WP)		0.50	4	0.42	0.97	0.83	0.65	0.67	0.23
	Low-volume application (WP)		0.50	4	0.12	1.60	0.97	0.23	0.54	0.71

[1] Rates are expressed in lb ai/100 gallons for the drench applications and in lb ai/200,000 fruit for the low-volume application.
[2] The LOQ is 0.02 ppm.
[3] PTI = Post-treatment interval, HAFT = Highest-Average Field Trial.

Kiwi Fruit (MRID# 46715504):

TABLE 6. Summary of Residue Data from Post-harvest Kiwifruit Trials with Fludioxonil (SC or WP).										
Commodity	Treatment (formulation)	Total Rate (lb ai)[1]	PTI[2] (days)	Residue Levels (ppm)[3]						
				n	Min.	Max.	HAFT[4]	Median	Mean	Std. Dev.
Whole fruit	Dip application (1.9 lb/gal SC)	0.25	0	4	2.50	5.10	5.00	3.75	3.78	1.42
			30	4	3.50	4.50	4.35	3.90	3.95	0.48
	Low-volume application (1.9 lb/gal SC)	0.25	0	4	1.40	4.20	3.50	2.40	2.60	1.21
	Dip application (50% WP)	0.25	0	4	0.67	4.20	3.40	3.40	2.92	1.55
	Dip application (50% WP)	0.50	0	4	5.50	7.50	7.15	6.60	6.55	0.83
			30	4	3.70	8.00	6.70	6.00	5.93	1.82

1 Rates are expressed in lb ai/100 gallons for the dip application and in lb ai/200,000 fruit for the low-volume application.
2 Post-treatment interval; selected samples were refrigerated (7°C) for 30 days prior to sampling.
3 The method LOQ is 0.02 ppm.
4 HAFT = Highest-Average Field Trial.

Stone Fruit (MRID# 46715505):

TABLE 7. Summary of Residue Data from Post-harvest Stone Fruit Trials with Fludioxonil (SC or WP).										
Commodity	Formulation	PTI[3] (days)	Total Rate (lb ai)[1]	Residue Levels (ppm)[2]						
				n	Min.	Max.	HAFT[3]	Median	Mean	Std. Dev.
Peach	SC; Dip	0	0.25	8	1.80	5.00	4.80	2.50	3.00	1.27
	SC; Low-volume		0.25	8	0.77	2.90	2.75	1.00	1.50	0.85
	WP; Low-volume		0.25	4	1.40	3.90	2.65	1.90	2.28	1.14
	WP; Low-volume		0.50	4	2.30	5.50	4.45	4.45	4.18	1.35
Plum	SC; Dip	0	0.25	8	0.27	0.46	0.37	0.36	0.36	0.06
	SC; Low-volume		0.25	8	0.13	0.66	0.55	0.31	0.32	0.17
	WP; Low-volume		0.25	4	0.19	0.71	0.57	0.31	0.38	0.25
	WP; Low-volume		0.50	4	<0.02	1.30	1.30	0.85	0.75	0.65

1 Rates are expressed in lb ai/100 gallons for the dip application and in lb ai/200,000 fruit for the low-volume application.
2 The method LOQ is 0.02 ppm. For calculation of the median, mean and standard deviation, ½LOQ (0.01 ppm) was used for samples with residues <LOQ.
3 PTI = Post-treatment interval, HAFT = Highest-Average Field Trial.

Cherry (MRID# 46715506):

TABLE 8. Summary of Residue Data from Post-harvest Cherry Trials with Fludioxonil (SC or WP).										
Trt# (formulation)	Commodity	PTI[1] (days)	Total Rate (lb ai/100 gal)	Residue Levels (ppm)[2]						
				n	Min.	Max.	HAFT[2]	Median	Mean	Std. Dev.
#2 (1.9 lb/gal SC)	Fruit	0	0.25	8	0.62	1.20	1.20	0.96	0.98	0.21
#3 (1.9 lb/gal SC)	Fruit	0	1.0	8	2.00	6.00	4.50	3.40	3.63	1.27
#4 (50% WP)	Fruit	0	0.25	4	0.75	1.00	0.98	0.97	0.92	0.12
#5 (50% WP)	Fruit	0	0.5	4	1.50	1.90	1.90	1.80	1.75	0.17

1 PTI = Post-treatment interval.
2 The LOQ is 0.02 ppm.
3 HAFT = Highest-Average Field Trial.

Conclusions: As the formulation type had no consistent effect on fludioxonil residues, HED recommends in favor of the proposed SC formulation. The maximum observed residues in peaches (5.5 ppm) exceeds the established tolerance of 5.0 ppm for tree nuts. HED thus recommends that RD requires the registrant to petition the Agency for an increased tolerance for stone fruit.

cc: G. Kramer (RAB1)
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This DER was originally prepared under contract by Dynamac Corporation (1910 Sedwick Rd., Building 100, Durham, NC 27713; submitted 7/31/2006). The DER has been reviewed by HED and revised to reflect current Office of Pesticide Programs (OPP) policies.

STUDY REPORT:

46715506. Ediger K. (2005) Fludioxonil-Magnitude of the Residues in or on Cherry Following Post-Harvest Applications. Lab Project Number: T006488-04. Unpublished study prepared by Syngenta Crop Protection. 112 pages.

EXECUTIVE SUMMARY:

Four post-harvest trials using sweet and tart cherries were conducted in CA and NY during 2004. At each trial location, cherries received a single, post-harvest dip application of fludioxonil, formulated as a 1.9 lb/gal suspension concentrate (SC) or a 50% wettable powder (WP). Each trial consisted of three or five different treatments, including a control (Trt #1); a single dip application using the SC formulation at 0.25 lb ai/100 gal with 300 ppm of wax (Trt #2); a single dip application using the SC formulation at 1.0 lb ai/100 gal with 1200 ppm of wax (Trt #3); a single dip application using the WP formulation at 0.25 lb ai/100 gal with 300 ppm of wax (Trt #4); and a single dip application using the WP formulation at 0.5 lb ai/100 gal with 600 ppm of wax (Trt #5). Following application, the fruit were allowed to dry, and duplicate treated samples were collected from each treatment and placed in frozen storage. In addition at two trial sites, cherry samples from Treatments #2 and #5 were gently washed prior to sampling and/or were refrigerated for approximately 5 or 10 days prior to sampling. Samples were stored frozen from collection to analysis for up to 7.4 months, an interval supported by available storage stability data.

The high-performance liquid chromatography (HPLC)/ultraviolet (UV) method (Method AG-597B) used to determine fludioxonil residues in/on cherries is the current tolerance enforcement method for plants and was adequately validated in conjunction with the field sample analyses. For this method, residues are extracted with acetonitrile (ACN):water, filtered, concentrated, and partitioned into methyl tert-butyl ethyl (MTBE). Residues are then solvent exchanged into toluene and cleaned up using silica and phenyl solid-phase extraction (SPE) cartridges. Purified residues are then analyzed by HPLC/UV using a normal-phase amino column with a mobile phase of hexane:methanol:isopropyl alcohol. The validated limit of quantitation (LOQ) is 0.02 ppm, and the limit of detection (LOD) was estimated to be ~0.01 ppm.

Immediately following a single post-harvest dip application of the SC formulation, residues in/on cherries were 0.62-1.2 ppm from Treatment #2 and 2.0-6.0 ppm from Treatment #3. Following the dip application of the WP, residues in/on cherries were 0.75-1.0 ppm from Treatment #4 and were 1.5-1.9 ppm from Treatment #5. Average residues were 0.98 and 3.63 ppm for Treatments #2 and #3 (SC formulation) and 0.92 and 1.75 ppm for Treatments #4 and #5. A comparison of Treatments #2 and #4 indicates that residues in/on cherries were similar for the two formulations.

Comparison of residues in/on washed fruit vs. unwashed fruit indicates that residues were either slightly reduced or not affected by washing. Similarly refrigerated storage for intervals up to 10 days had only a marginal effect on residue levels, with 10-day samples showing a slight but insignificant decline in residues.

STUDY/WAIVER ACCEPTABILITY/DEFICIENCIES/CLARIFICATIONS:

Under the conditions and parameters used in the study, the post-harvest trial residue data on cherries are classified as scientifically acceptable. The acceptability of this study for regulatory purposes is addressed in the forthcoming U.S. EPA Residue Chemistry Summary Document [DP# 325160].

COMPLIANCE:

Signed and dated Good Laboratory Practice (GLP), Quality Assurance and Data Confidentiality statements were provided. The study author cited deviations from GLP compliance that included gross sample weight determinations and field history which were not collected according to GLP guidelines, and application solution data were not generated as required in 40 CFR part 160.113(a)(1) and (3). None of these deviations affect the acceptability of the study.

A. BACKGROUND INFORMATION

Fludioxonil is a contact fungicide, which inhibits protein kinase, leading to reduced fungal growth and development. Tolerances are currently established for residues of fludioxonil, 4-(2,2-difluoro-1,3-benzodioxol-4-yl)-1*H*-pyrrole-3-carbonitrile, in/on various plant commodities at levels ranging from 0.01-500 ppm [40 CFR §180.516], including a 5 ppm tolerance for the stone fruit crop group.

TABLE A.1. Fludioxonil Nomenclature.

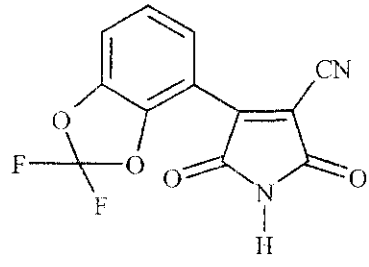
Compound	
Common name	Fludioxonil
Company experimental name	CGA-173506

TABLE A.1. Fludioxonil Nomenclature.	
IUPAC name	4-(2,2-difluoro-1,3-benzodioxol-4-yl)-*1H*-pyrrole-3-carbonitrile
CAS name	4-(2,2-difluoro-1,3-benzodioxol-4-yl)-*1H*-pyrrole-3-carbonitrile
CAS registry number	131341-86-1
End-use products (EP)	Scholar® Fungicide (50% WP; EPA Reg. No. 100-969) Scholar® Fungicide (1.9 lb/gal SC; EPA Reg. No. 100-###)

TABLE A.2. Physicochemical Properties of Fludioxonil.		
Parameter	Value	Reference
Melting point	199.8 °C	Provided in this study
pH	8-9 @ 25 °C (1% aqueous Dispersion)	
Density	1.54 g/cm^3 typical at 23 °C	
Water solubility (25 °C)	1.8 mg/L	
Solvent solubility (mg/L @ 25 °C)	Ethanol 44,000 Acetone 190,000 Toluene 2,700 n-Octanol 20,000 n-Hexane 7.8	
Vapor pressure (25 °C)	2.9 x 10^{-9} mm Hg	
Dissociation constant, pK_a	pK_{a1} <0 pK_{a2} ~ 14.1	
Octanol/water partition coefficient, Log(K_{OW})	4.12 @ 25 °C	
UV/visible absorption spectrum	12,384 l/mol x cm @266 nm (neutral solution) 12,327 l/mol x cm @ 265 nm (acidic solution) 11,790 l/mol x cm @ 271 nm (basic solution)	

B. EXPERIMENTAL DESIGN

B.1. Study Site Information

The untreated cherries used for post-harvest treatments were obtained from commercial or research orchards. As applications were made post-harvest at indoor facilities, variables such as soil type, length of growing season and weather are not relevant to the current study.

Fludioxonil (SC or WP) was applied to cherries as a single dip application (Table B.1.1), including a finishing wax at 300-1200 ppm. For application, fruits were placed in a bucket or tray containing the application solution and were gently agitated in solution for approximately one minute

TABLE B.1.1. Study Use Pattern on Cherries: Post-harvest Application of Fludioxonil (SC or WP).

Location (City, State; Year) Trial ID	Postharvest Application					
	Method; Timing	Trt#	Formulation	Single Rate (lb ai/100 gal)	Total Rate (lb ai/100 gal)	Additives[1]
Hudson, NY; 2004 5295	Single dip post-harvest application	2	1.9 lb/gal SC	0.25	0.25	Wax
		3	1.9 lb/gal SC	1.0	1.0	Wax
		4	50% WP	0.25	0.25	Wax
		5	50% WP	0.5	0.5	Wax
Hudson, NY; 2004 5296	Single dip post-harvest application	2	1.9 lb/gal SC	0.25	0.25	Wax
		3	1.9 lb/gal SC	1.0	1.0	Wax
Riverside, CA; 2004 5297	Single dip post-harvest application	2	1.9 lb/gal SC	0.28	0.28	Wax
		3	1.9 lb/gal SC	1.3	1.3	Wax
		4	50% WP	0.25	0.25	Wax
		5	50% WP	0.5	0.5	Wax
Visalia, CA; 2004 5298	Single dip post-harvest application	2	1.9 lb/gal SC	0.25	0.25	Wax
		3	1.9 lb/gal SC	1.0	1.0	Wax

[1] Decco PNP Custr 251 Finishing Wax was added to the dipping solution at rates of 300 ppm (Trt#s 2 and 3), 600 ppm (Trt# 4), and 1200 ppm (Trt# 3).

B.2. Sample Handling and Preparation

The fruit was allowed to dry after application, and then duplicate treated samples were collected from each treatment and placed in frozen storage on the day of treatment. After collection, selected subsamples from Treatments #2 and #5 at two trial sites were also washed by gently rubbing the fruit by hand under running water for ~10 seconds. In addition, cherry samples from Treatments #2 and #5 were refrigerated (7 ± 8 °C) for approximately 5 or 10 days prior to sampling in order to examine residue decline under refrigerated conditions. All samples were shipped frozen to Syngenta Corp Protection, Inc., Greensboro, NC for sample preparation, where samples were stored at -20 °C. For analysis, the prepared samples were later shipped frozen to EN-CAS Laboratories, Winston-Salem, NC, where samples were stored at -20 °C.

B.3. Analytical Methodology

Cherry samples were analyzed using HPLC/UV method (Method AG-597B), "Analytical Method for the Determination of CGA-173506 in Crops by High Performance Liquid Chromatography Including Validation Data." This method is the current tolerance enforcement method for determining fludioxonil in plant commodities.

For this method, residues are extracted with ACN:water (90:10, v/v), filtered, and concentrated to remove the ACN. Residues were diluted with a saturated salt solution and partitioned into MTBE. Residues were then solvent exchanged into toluene, diluted with hexane, and cleaned up using a silica SPE cartridge eluted with toluene:dichloromethane (1:1, v/v). Residues were next concentrated to dryness, reconstituted in methanol:water, and further purified using a phenyl SPE cartridge eluted with acetone. Purified residues were concentrated, reconstituted in the HPLC mobile phase, hexane:methanol:isopropyl alcohol (90:6:6, v/v/v), and analyzed by HPLC/UV at 268 nm using a normal phase amino column and external standards. The LOQ is 0.02 ppm, and the LOD was defined as the lowest standard injected (1 ng), which is equivalent to ~0.01 ppm based on peak areas.

In conjunction with the analysis of field trial samples, the above method was validated using control samples of cherries fortified with fludioxonil at 0.02-10.0 ppm.

C. RESULTS AND DISCUSSION

The number of cherry post-harvest trials is adequate, and geographic representation of the field trial data is not relevant as the proposed use is for post-harvest application in fruit packing houses. A total of four post-harvest trials were conducted in which cherries received a single post-harvest application of fludioxonil, formulated as a 1.9 lb/gal SC or 50% WP. Each trial consisted of three or five different treatments, including a control (Trt #1); a single dip application using the SC formulation at 0.25 lb ai/100 gal with 300 ppm of wax (Trt #2); a single dip application using the SC formulation at 1.0 lb ai/100 gal with 1200 ppm of wax (Trt #3); a single dip application using the WP formulation at 0.25 lb ai/100 gal with 300 ppm of wax (Trt #4); and a single dip application using the WP formulation at 0.5 lb ai/100 gal with 600 ppm of wax (Trt #5). Following application the fruit were allowed to dry, and duplicate treated samples were collected from each treatment and placed in frozen storage. In addition at two trial sites, cherry subsamples from Trt #2 and #5 were gently washed prior to sampling and/or were refrigerated for approximately 5 or 10 days prior to sampling.

The HPLC UV method (Method AG-597B) used to determine fludioxonil residues in/on cherry samples was adequately validated in conjunction with the field sample analyses. Concurrent method recoveries from samples fortified at 0.02-10.0 ppm ranged from 68-109% and the overall average was 84 ± 12% (Table C.1). Apparent residues of fludioxonil were <LOQ in/on 11 control samples and 0.04 ppm in/on one control sample. The validated method LOQ is 0.02 ppm and the estimated LOD is ~0.01 ppm. Adequate sample calculations and example chromatograms were provided.

Cherry samples were stored for up to 7.4 months prior to extraction for analysis (Table C.2). Adequate storage stability data are available indicating that fludioxonil is stable at -20 °C for up to 28 months on grapes (D258870, W. Donovan, 12/20/99). These data will support the frozen storage intervals in the current trials.

Immediately following a single post-harvest dip application of the SC formulation to cherries, residues were 0.62-1.2 ppm from the 0.25 lb ai/100 gal rate including wax at 300 ppm and were 2.0-6.0 ppm from the 1.0 lb ai/100 gal rate with wax at 1200 ppm (Table C.3). Following the dip application of the WP, residues in/on cherries were 0.75-1.0 ppm from the 0.25 lb ai/100 gal rate including wax at 300 ppm and were 1.5-1.9 ppm from the 0.5 lb ai/100 gal rate with wax at 600 ppm. Average residues were 0.98 and 3.63 ppm for Treatment #2 and #3 (SC formulation) and 0.92 and 1.75 ppm for Treatments #4 and #5 (WP formulation, Table C.4.1). A comparison of Treatments #2 and #4 indicates that residues in/on cherries were similar for the two formulations.

Comparisons of residues in/on washed fruit vs. unwashed fruit indicate that residues were either slightly reduced or not affected by washing. Similarly refrigerated storage for intervals up to 10 days had only a marginal effect on residue levels, with 10-day samples showing a slight but insignificant decline in residues (Table C.4.2).

TABLE C.1. Summary of Concurrent Method Recoveries of Fludioxonil from Cherries.

Analyte	Matrix	Spike level (ppm)	Sample size (n)	Recoveries (%)	Mean ± std dev (%)
Fludioxonil	Cherry	0.02	1	73	NA
		0.2	1	102	NA
		1.0	3	109, 83, 85	92 ± 14
		2.0	5	84, 68, 88, 76, 84	80 ± 8
		5.0	1	80	NA
		10.0	1	74	NA
		Overall	12	68-109	84 ± 12

TABLE C.2 Summary of Storage Conditions.

Matrix	Storage Temperature (°C)	Actual Storage Duration (months)	Interval of Demonstrated Storage Stability (months)[1]
Cherries	-20	4.7-7.4	28

[1] D258870, W. Donovan, 12/20/99.

TABLE C.3. Residue Data from Cherry Post-harvest Trials with Fludioxonil (SC or WP).

Trial ID (City, State; Year)	Type/Variety	Formulation	TRT #	Total Rate (lb ai/100 gal)	Commodity	PTI[1] (days)	Fludioxonil Residues (ppm)[2]
Hudson, NY; 2004 5295	Tart/ Montmorency	1.9 lb/gal SC	2	0.25	Fruit	0	0.86, 0.94
						5	1.1, 1.2
						10	0.88, 0.91
					Washed Fruit	0	0.74, 0.68
						5	0.97, 1.2
		1.9 lb/gal SC	3	1.0	Fruit	0	2.9, 2.9
		50% WP	4	0.25	Fruit	0	0.75, 0.98
		50% WP	5	0.5	Fruit	0	1.5, 1.8
						5	1.5, 1.7
						10	1.7, 1.6
					Washed Fruit	0	0.80, 1.0
						5	0.96, 1.6
Hudson, NY; 2004 5296	Tart/ Montmorency	1.9 lb/gal SC	2	0.25	Fruit	0	0.62, 0.85
		1.9 lb/gal SC	3	1.0	Fruit	0	2.0, 2.7
Riverside, CA; 2004 5297	Sweet/ Bing	1.9 lb/gal SC	2	0.28	Fruit	0	1.2, 1.2
						5	1.0, 1.0
						10	0.85, 1.3
					Washed Fruit	0	0.84, 1.1
						5	0.95, 0.98
		1.9 lb/gal SC	3	1.3	Fruit	0	4.1, 3.9
		50% WP	4	0.25	Fruit	0	1.0, 0.95
		50% WP	5	0.5	Fruit	0	1.8, 1.9
						5	1.4, 1.4
						10	1.2, 1.1
					Washed Fruit	0	1.4, 1.3
						5	1.6, 1.3
Visalia, CA; 2004 5298	Sweet/ Brook	1.9 lb/gal SC	2	0.25	Fruit	0	0.98, 1.2
		1.9 lb/gal SC	3	1.0	Fruit	0	6.0, 4.5

[1] Post-treatment sampling interval.
[2] The validated method LOQ is 0.02 ppm.

TABLE C.4.1. Summary of Residue Data from Post-harvest Cherry Trials with Fludioxonil (SC or WP).

Trt# (formulation)	Commodity	PTI[1] (days)	Total Rate (lb ai/100 gal)	Residue Levels (ppm)[1]						
				n	Min.	Max.	HAFT[2]	Median	Mean	Std. Dev.
#2 (1.9 lb/gal SC)	Fruit	0	0.25	8	0.62	1.20	1.20	0.96	0.98	0.21
#3 (1.9 lb/gal SC)	Fruit	0	1.0	8	2.00	6.00	5.25	3.40	3.63	1.27
#4 (50% WP)	Fuit	0	0.25	4	0.75	1.00	0.98	0.97	0.92	0.12
#5 (50% WP)	Fruit	0	0.5	4	1.50	1.90	1.90	1.80	1.75	0.17

[1] Post-treatment interval.
[2] The LOQ is 0.02 ppm.
[3] HAFT = Highest-Average Field Trial.

TABLE C.4.2. Summary of Residue Decline Data from Cherries Held in Refrigerated Storage (7 °C) after Treatment with Fludioxonil (SC or WP).

Trt# (formulation)	Commodity	PTI[1] (days)	Total Rate (lb ai/100 gal)	Residue Levels (ppm)[1]						
				n	Min.	Max.	HAFT[2]	Median	Mean	Std. Dev.
#2 (1.9 lb/gal SC)	Fruit	0	0.25	4	0.86	1.20	1.20	1.07	1.05	0.18
		5		4	1.00	1.20	1.15	1.05	1.08	0.10
		10		4	0.85	1.30	1.08	0.90	0.99	0.21
#5 (50% WP)	Fruit	0	0.50	4	1.50	1.90	1.85	1.80	1.75	0.17
		5		4	1.40	1.70	1.60	1.45	1.50	0.14
		10		4	1.10	1.70	1.65	1.40	1.40	0.29

[1] Post-treatment interval.
[2] The LOQ is 0.02 ppm.
[3] HAFT = Highest-Average Field Trial.

D. CONCLUSION

The cherry post-harvest trial data are adequate and will support the post-harvest use of the 1.9 lb/gal SC formulation as a single dip application at up to 1.0 lb ai/100 gal and the use of the WP formulation at up to 0.5 lb ai/100 gal. Immediately following a single post-harvest dip application of the SC formulation, residues in/on cherries were 0.62-1.2 ppm from Treatment #2 and 2.0-6.0 ppm from Treatment #3. Following the dip application of the WP, residues in/on cherries were 0.75-1.0 ppm from Treatment #4 and were 1.5-1.9 ppm from Treatment #5. Average residues were 0.98 and 3.63 ppm for Treatments #2 and #3 (SC formulation) and 0.92 and 1.75 ppm for Treatments #4 and #5. The data will also support the inclusion of a commercial finishing wax in the treatment solution.

E. REFERENCES

DP#: 258870
Subject: PP# 7E04919. Fludioxonil for use on Grapes. Evaluation of Residue Data and Analytical Methods.
From: W. Donovan
To: M. Waller
Dated: 12/20/99
MRID: 44382322-4438370

F. DOCUMENT TRACKING

RDI: RAB1 Chemists (11/15/06)
Petition Number(s): NA
DP#: 325160
PC Code: 071503

Template Version June 2005

Primary Evaluator — Date: 16-NOV-2006
George F. Kramer, Ph.D., Senior Chemist
Registration Action Branch (RAB1)
Health Effects Division (HED) (7509P)

Approved by — Date: 16-NOV-2006
P.V. Shah, Ph.D., Branch Senior Scientist
RAB1/HED (7509P)

This DER was originally prepared under contract by Dynamac Corporation (1910 Sedwick Rd., Building 100, Durham, NC 27713; submitted 7/31/2006). The DER has been reviewed by HED and revised to reflect current Office of Pesticide Programs (OPP) policies.

STUDY REPORT:

46715501. Ediger K. (2005) Fludioxonil-Magnitude of Residues in or on Oranges and Grapefruit Following Post-Harvest Applications. Lab Project Numbers: T002040-03. Unpublished study prepared by Syngenta Crop Protection. 177 pages.

EXECUTIVE SUMMARY:

Four post-harvest trials were conducted on oranges (2 trials) and grapefruit (2 trials) in CA and TX during 2004. At each location, oranges or grapefruit received one or two post-harvest applications of fludioxonil, formulated as a 1.9 lb/gal suspension concentrate (SC) or a 50% wettable powder (WP). Each trial consisted of six or seven different treatments, including a control (Trt #1); a single application of the SC formulation as a dip at 0.5 lb ai/100 gal (Trt #2) or low-volume application at 0.5 lb ai/250,000 fruit (Trt #3); combined applications using the SC as a drench at 0.25 or 0.5 lb ai/100 gal followed immediately by a low-volume application at 0.25 or 0.5 lb ai/250,000 lb fruit, for total rates of 0.5 and 1.0 lb ai (Trts #4 and #5); and a single application of the WP formulation as a low-volume application at 0.5 or 1.0 lb ai/250,000 fruit (Trts #6 and #7). Each treatment included the use of a commercial finishing wax at a rate of 25 lbs/250,000 lb fruit. Following application, fruits were allowed to dry, and duplicate treated samples were collected from each treatment on the day of application and placed in frozen storage. In addition, selected orange samples from Treatments 2, 4 and 5 were refrigerated for approximately 7 or 14 days prior to sampling to examine residue decline during refrigerated storage. Subsamples of washed fruit or peeled fruit were also collected from selected treatments. Samples were stored frozen from collection to analysis for up to 2.3 months, an interval supported by available storage stability data.

The high-performance liquid chromatography (HPLC)/ultraviolet (UV) method (Method AG-597B) used to determine fludioxonil residues in/on oranges and grapefruits is the current tolerance enforcement method for plants and was adequately validated in conjunction with the field sample analyses. For this method, residues are extracted with acetonitrile (ACN):water, filtered, concentrated, and partitioned into methyl tert-butyl ethyl (MTBE). Residues are then solvent exchanged into toluene and cleaned up using silica and phenyl solid-phase extraction (SPE) cartridges. Purified residues are then analyzed by HPLC/UV using a normal-phase amino column with a mobile phase of hexane:methanol:isopropyl alcohol. The validated limit of

quantitation (LOQ) is 0.02 ppm, and the limit of detection (LOD) was estimated to be ~0.01 ppm, based on the lowest standard injected.

Following post-harvest application(s) of the SC formulation at a total rate of 0.5 lb ai, residues in/on whole oranges were highest for the dip application (0.70-1.10 ppm; ave. 0.91 ppm), and were progressively less for the single low-volume application (0.37-0.74 ppm; ave. 0.55 ppm) and the combined drench and low-volume application (0.32-0.53 ppm; ave. 0.39 ppm). Residues in/on oranges following the combined application were higher at the 1.0 lb ai rate (0.75-0.86 ppm) than at 0.5 lb ai rate, but the combined application at 1.0 lb ai still had lower residues than the dip treatment at 0.5 lb ai/100 gal. Following the low-volume application of the WP formulation, residues in/on oranges were 0.62-0.85 ppm for the 0.5 lb ai rate and 0.90-1.0 ppm for the 1.0 lb ai rate, with average residues of 0.73 and 0.95 ppm, respectively. Comparing the low-volume application at the 0.5 lb ai rate for the two formulations, residues were slightly higher for the WP formulation than for the SC formulation.

Residues levels in/on whole grapefruit for the different treatments showed the same relative distribution of residues as observed in oranges. For the SC formulation at the 0.5 lb ai rate, residues in/on whole grapefruit were highest for the dip application (0.60-0.95 ppm; ave. 0.76 ppm), and lower for the single low-volume application (0.07-0.67 ppm; ave. 0.39 ppm) and the combined drench and low-volume application (0.14-0.34 ppm; ave. 0.25 ppm). For the combined drench and low-volume application, residues in/on whole grapefruit were higher at the 1.0 lb ai rate (0.17-0.59 ppm) than at 0.5 lb ai rate, but were still lower than for the dip treatment at 0.5 lb ai/100 gal. Following the low-volume application of the WP formulation, residues in/on whole grapefruit were 0.05-0.92 ppm for the 0.5 lb ai rate and 1.50 ppm for the 1.0 lb ai rate, with average residues of 0.49 and 1.50 ppm, respectively. Comparing the low-volume application at the 0.5 lb ai rate for the two formulations, residues were slightly higher for the WP formulation than for the SC formulation.

Washing or peeling of treated fruits had a similar effect on residues levels for both oranges and grapefruit from each type of treatment. Washing reduced residues in/on oranges and grapefruit by 12-86%, and peeling reduced residue levels by 92-96%. In addition, short-term refrigeration (7 °C) of treated fruit for up to ~14 days had essentially no effect on residues levels in/on whole oranges.

STUDY/WAIVER ACCEPTABILITY/DEFICIENCIES/CLARIFICATIONS:

Under the conditions and parameters used in the study, the orange and grapefruit post-harvest trial residue data are classified as scientifically acceptable. The acceptability of this study for regulatory purposes is addressed in the forthcoming U.S. EPA Residue Chemistry Summary Document [DP# 325160].

COMPLIANCE:

Signed and dated Good Laboratory Practice (GLP), Quality Assurance and Data Confidentiality statements were provided. The study author cited deviations from GLP compliance that included gross sample weight determinations and field history which were not collected according to GLP

guidelines, and application solution data were not generated as required in 40 CFR part 160.113(a)(1) and (3). Solution generation for trial 5275 used the incorrect stock solution of the SC formulation and resulted in application rates 11.09% higher than targeted. The author acknowledges that this could result in potentially higher residues, but this was not considered significant when accounting for overall experimental error.

A. BACKGROUND INFORMATION

Fludioxonil is a contact fungicide, which inhibits protein kinase, leading to reduced fungal growth and development. Tolerances are currently established for residues of fludioxonil, 4-(2,2-difluoro-1,3-benzodioxol-4-yl)-1*H*-pyrrole-3-carbonitrile, in/on various plant commodities at levels ranging from 0.01-500 ppm [40 CFR § 180.516], including a 10 ppm tolerance for the citrus fruit crop group.

TABLE A.1. Fludioxonil Nomenclature.

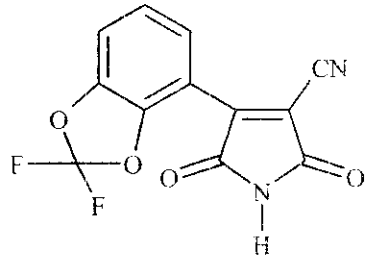
Compound	
Common name	Fludioxonil
Company experimental name	CGA-173506
IUPAC name	4-(2,2-difluoro-1,3-benzodioxol-4-yl)-*1H*-pyrrole-3-carbonitrile
CAS name	4-(2,2-difluoro-1,3-benzodioxol-4-yl)-*1H*-pyrrole-3-carbonitrile
CAS registry number	131341-86-1
End-use products (EP)	Scholar® Fungicide (50% WP; EPA Reg. No. 100-969) Scholar® Fungicide (1.9 lb/gal SC; EPA Reg. No. 100-###)

TABLE A.2. Physicochemical Properties of Fludioxonil.

Parameter	Value	Reference
Melting point	199.8 °C	Provided in this study
pH	8-9 @ 25 °C (1% aqueous Dispersion)	
Density	1.54 g/cm^3 typical at 23 °C	
Water solubility (25 °C)	1.8 mg/L	
Solvent solubility (mg/L @ 25 °C)	Ethanol 44,000 Acetone 190,000 Toluene 2,700 n-Octanol 20,000 n-Hexane 7.8	
Vapor pressure (25 °C)	2.9 x 10^{-9} mm Hg	
Dissociation constant, pK_a	pK_{a1} <0 pK_{a2} ~ 14.1	
Octanol/water partition coefficient, Log(K_{OW})	4.12 @ 25 °C	
UV/visible absorption spectrum	12,384 l/mol x cm @266 nm (neutral solution) 12,327 l/mol x cm @ 265 nm (acidic solution) 11,790 l/mol x cm @ 271 nm (basic solution)	

B. EXPERIMENTAL DESIGN

B.1. Study Site Information

The untreated orange and grapefruit samples used for post-harvest treatments were obtained from commercial or research orchards. As applications were made post-harvest at indoor facilities, variables such as soil type, length of growing season and weather are not relevant to the current study.

Fludioxonil (SC or WP) was applied to oranges and grapefruits as dip, drench or low-volume applications (Table B.1.1). For the dip applications, fruits were placed in a bucket or tray containing the application solution and were gently agitated in solution for approximately one minute. For drench applications, the application solution was poured over the fruit. Low-volume applications were made by sending fruit through a packing line equipped with controlled-droplet applicators, brushes, belts, rollers, wig-wag or dribble applicators. For the two treatments (Trt#s 4 and 5) which included two applications, the drench and low-volume applications were made sequentially on the same day.

TABLE B.1.1. Study Use Pattern on Orange and Grapefruit: Post-harvest (PH) Application of Fludioxonil (SC or WP).

Location (City, State; Year) Trial ID	Post-harvest Applications						
	Trt #	Method; Timing[1]	Formulation	Application Type	Single Rates (lb ai)[2]	Total rate (lb ai)[2]	Additives[3]
Orange							
Parlier, CA, 2004 5275	2	One PH application	1.9 lb/gal SC	Dip	0.5	0.5	Wax
	3	One PH application	1.9 lb/gal SC	Low Volume	0.5	0.5	Wax
	4	Two PH applications	1.9 lb/gal SC	Drench + LV	0.25 + 0.25	0.5	Wax [4]
	5	Two PH applications	1.9 lb/gal FC	Drench + LV	0.5 + 0.5	1.0	Wax [4]
	6	One PH application	50% WP	Low Volume	0.5	0.5	Wax
	7	One PH application	50% WP	Low Volume	1.0	1.0	Wax
Visalia, CA, 2004 5276	2	One PH application	1.9 lb/gal SC	Dip	0.5	0.5	Wax
	3	One PH application	1.9 lb/gal SC	Low Volume	0.5	0.5	Wax
	4	Two PH applications	1.9 lb/gal SC	Drench + LV	0.25 + 0.25	0.5	Wax [4]
	5	Two PH applications	1.9 lb/gal SC	Drench + LV	0.5 + 0.5	1.0	Wax [4]
	6	One PH application	50% WP	Low Volume	0.5	0.5	Wax

TABLE B.1.1. Study Use Pattern on Orange and Grapefruit: Post-harvest (PH) Application of Fludioxonil (SC or WP).

Location (City, State; Year; Trial ID)	Post-harvest Applications						
	Trt #	Method; Timing[1]	Formulation	Application Type	Single Rates (lb ai)[2]	Total rate (lb ai)[2]	Additives[3]
Grapefruit							
Visalia, CA 2004 5277	2	One PH application	1.9 lb/gal SC	Dip	0.5	0.5	Wax
	3	One PH application	1.9 lb/gal SC	Low Volume	0.5	0.5	Wax
	4	Two PH applications	1.9 lb/gal SC	Drench + LV	0.25 + 0.25	0.5	Wax[4]
	5	Two PH applications	1.9 lb/gal SC	Drench + LV	0.5 + 0.5	1.0	Wax[4]
	6	One PH application	50% WP	Low Volume	0.5	0.5	Wax
	7	One PH application	50% WP	Low Volume	1.0	1.0	Wax
Mercedes, TX 2004 5278	2	One PH application	1.9 lb/gal SC	Dip	0.5	0.5	Wax
	3	One PH application	1.9 lb/gal SC	Low Volume	0.5	0.5	Wax
	4	Two PH applications	1.9 lb/gal SC	Drench + LV	0.25 + 0.25	0.5	Wax[4]
	5	Two PH applications	1.9 lb/gal SC	Drench + LV	0.5 + 0.5	1.0	Wax[4]
	6	One PH application	50% WP	Low Volume	0.5	0.5	Wax

[1] For treatments using two applications, the drench and low-volume (LV) applications were made sequentially on the same day.
[2] Rates for dip and drench applications are expressed in lb ai/100 gallons, and the rates for the LV applications are expressed in lb ai/250,000 lb fruit.
[3] Decco Lustr Finishing Wax was applied at a rate of 25 lbs/250,000 lb fruit.
[4] Wax was added only to the second application.

B.2. Sample Handling and Preparation

After application(s), the fruit were allowed to dry and then duplicate treated samples were collected from each treatment and placed in frozen storage on the day of treatment. After collection, selected subsamples were also peeled or washed by gently rubbing the fruit by hand under running water for ~10 seconds. For peeled samples, whole fruit were frozen and later peeled at Syngenta.

In addition, selected orange samples from Treatments 2, 4 and 5 were refrigerated (7 ± 8 °C) for approximately 7 or 15 days prior to sampling in order to examine residue decline under normal refrigeration conditions. All samples were shipped frozen to Syngenta Corp Protection, Inc., Greensboro, NC for sample preparation, where samples were stored at -20 °C. For analysis, the prepared samples were later shipped frozen to EN-CAS Laboratories, Winston-Salem, NC, where samples were stored at -20 °C.

B.3. Analytical Methodology

Orange and grapefruit samples were analyzed using HPLC/UV method (Method AG-597B), "Analytical Method for the Determination of CGA-173506 in Crops by High Performance Liquid Chromatography Including Validation Data." This method is the current tolerance enforcement method for determining fludioxonil in plant commodities.

For this method, residues are extracted with ACN:water (90:10, v/v), filtered, and concentrated to remove the ACN. Residues were diluted with a saturated salt solution and partitioned into MTBE. Residues were then solvent exchanged into toluene, diluted with hexane, and cleaned up using a silica SPE cartridge eluted with toluene:dichloromethane (1:1, v/v). Residues were next

concentrated to dryness, reconstituted in methanol:water, and further purified using a phenyl SPE cartridge eluted with acetone. Purified residues were concentrated, reconstituted in the HPLC mobile phase, hexane:methanol:isopropyl alcohol (90:6:6, v/v/v), and analyzed by HPLC/UV at 268 nm using a normal-phase amino column and external standards. The LOQ is 0.02 ppm, and the LOD was defined as the lowest standard injected (1 ng), which is equivalent to ~0.01 ppm based on peak areas.

In conjunction with the analysis of trial samples, the above method was validated using control samples of oranges and grapefruit fortified with fludioxonil at 0.02-2.0 ppm.

C. RESULTS AND DISCUSSION

The number of orange and grapefruit post-harvest trials is adequate, and geographic representation of the trial data is not relevant as the proposed use is for post-harvest application in fruit packing houses. A total of four post-harvest trials were conducted in which oranges (2 trials) and grapefruits (2 trials) received one or two post-harvest applications of fludioxonil, formulated as a 1.9 lb/gal SC or 50% WP. Each trial consisted of six or seven different post-harvest treatments, including the control (Trt #1). The Treatment 2 was a single dip application using the SC formulation at 0.5 lb ai/100 gal, and Treatment 3 was a single low-volume application using the SC formulation at 0.5 lb ai/250,000 lb fruit. Treatment 4 used the SC formulation as a drench at 0.25 lb ai/100 gal followed immediately by a low-volume application at 0.25 lb ai/250,000 lb fruit. Treatment 5 was identical to Treatment 4, but applications were made at 0.5 lb ai/100 gal and 0.5 lb ai/250,000 fruit. Treatments 6 and 7 used the WP formulation as a single low-volume application at 0.5 or 1.0 lb ai/250,000 fruit, respectively.

Following application the fruit were allowed to dry, and duplicate treated samples were collected from each treatment and placed in frozen storage. In addition, selected orange samples from Treatments 2, 4 and 5 were refrigerated for approximately 7 or 15 days prior to sampling to examine residue decline during refrigerated storage. Subsamples of washed fruit or peeled fruit were also collected from each treatment.

The HPLC/UV method (Method AG-597B) used to determine fludioxonil residues in/on orange and grapefruit samples was adequately validated in conjunction with the field sample analyses. Method validation recoveries averaged 98 and 89% at fortifications of 0.02 and 0.2 ppm, respectively, and concurrent method recoveries averaged 81-92% at fortifications of 0.02-2.0 ppm (Table C.1). Apparent residues of fludioxonil was <LOQ in/on all control samples. The validated method LOQ is 0.02 ppm and the estimated LOD is ~0.01 ppm. Adequate sample calculations and example chromatograms were provided.

Citrus fruit samples were stored for up to 2.3 months prior to extraction for analysis (Table C.2.). The study authors cited storage stability data indicating that fludioxonil is stable at -20 °C for at least 13.8 months in whole citrus fruit and 9.4 months in citrus juice. These data will support the frozen storage intervals in the current trials.

Following post-harvest application(s) of the SC formulation of fludioxonil to oranges at a total rate of 0.5 lb ai (Table C.3), residues in/on whole fruit were highest for the dip application (0.70-1.10 ppm), and were progressively less for the single low-volume application (0.37-0.74 ppm) and the combined drench and low-volume application (0.32-0.53 ppm). Average fludioxonil residues were 0.91 ppm for the dip application, 0.55 ppm for the low-volume application, and 0.39 ppm for the combined drench and low-volume applications (Table C.4.1). For the combined drench and low-volume application of the SC, residues in/on whole fruit were higher at the 1.0 lb ai rate (0.75-0.86 ppm) than at 0.5 lb ai rate, but the combined application at 1.0 lb ai still had lower residues than the dip treatment at 0.5 lb ai. Following the low-volume application of the WP formulation to oranges, residues in/on whole fruit were 0.62-0.85 ppm for the 0.5 lb ai rate and 0.90-1.0 ppm for the 1.0 lb ai rate, with average residues of 0.73 and 0.95 ppm, respectively. Comparing the low-volume application at the 0.5 lb ai rate for the two formulations, residues were slightly higher for the WP formulation than for the SC formulation.

Residues levels in/on whole grapefruit for the different treatments showed the same relative distribution of residues as observed in oranges. For the SC formulation at the 0.5 lb ai rate, residues in/on whole fruit were highest for the dip application (0.60-0.95 ppm), and lower for the single low-volume application (0.07-0.67 ppm) and the combined drench and low-volume application (0.14-0.34 ppm). Average residues were 0.76 ppm for the dip application, 0.39 ppm for the low-volume application, and 0.25 ppm for the combined drench and low-volume applications (Table C.4.2). For the combined drench and low-volume application of the SC, residues in/on whole grapefruit were higher at the 1.0 lb ai rate (0.17-0.59 ppm) than at 0.5 lb ai rate, but the combined application at 1.0 lb ai still had lower residues than the dip treatment at 0.5 lb ai. Following the low-volume application of the WP formulation, residues in/on whole grapefruit were 0.05-0.92 ppm for the 0.5 lb ai rate and 1.50 ppm for the 1.0 lb ai rate, with average residues of 0.49 and 1.50 ppm, respectively. Comparing the low-volume application at the 0.5 lb ai rate for the two formulations, residues were slightly higher for the WP formulation than for the SC formulation.

Washing or peeling of treated fruits had a similar effect on residues levels for both oranges and grapefruit from each type of treatment. Washing reduced residues by 18-86% for treated oranges and 12-63% for treated grapefruit. Peeling reduced residue levels by 92-96% for both oranges and grapefruits, to levels of <0.02-0.11 ppm.

Refrigerated storage up to ~14 days had essentially no effect on residues levels in/on whole oranges (Table C.4.3). Following application(s) of the SC formulation to oranges at rates totaling 0.5 lb ai, average residues at 0, ~7 and ~14 days post-treatment were respectively 0.55, 0.53 and 0.61 ppm for the dip application, 0.39, 0.43, and 0.45 ppm for the low-volume application, and 0.81, 0.62, and 0.52 ppm for the combined drench and low-volume application.

TABLE C.1. Summary of Method Recoveries of Fludioxonil from Orange and Grapefruit.

Analyte	Matrix	Spike level (ppm)	Sample size (n)	Recoveries (%)	Mean ± std dev (%)[1]
Method Validation					
Fludioxonil	Whole Oranges	0.02	2	98, 98	98
		0.20	2	90, 87	89
Concurrent					
Fludioxonil	Orange and Grapefruit[2]	0.02	4	103, 96, 74, 93	92 ± 12
		0.2	4	78, 81, 105, 91	89 ± 12
		0.5	2	77, 84	81
		1.0	4	70, 97, 92, 92	88 ± 12
		2.0	2	93, 89	91

[1] Standard deviations were only calculated for fortifications with >3 samples.
[2] Samples included whole fruit, peeled fruit and washed whole fruit.

TABLE C.2 Summary of Storage Conditions.

Matrix	Storage Temperature (°C)	Actual Storage Duration (months)	Interval of Demonstrated Storage Stability (months)[1]
Citrus fruit	-20	0.7-2.3	13.8

[1] MRID 46162301.

TABLE C.3 Residue Data from Citrus Post-harvest Trials with Fludioxonil (SC or WP).

Trial ID (City, State: Year)	Type (Variety)	Trt#	Formulation	Total Rate (lb ai)[1]	Commodity	Post-treatment Interval (days)	Fludioxonil Residues (ppm)[2]
Parlier, CA; 2004 5275	Orange (Valencia)	2	1.9 lb/gal SC	0.5	Whole fruit	0	0.70, 1.0
					Peeled fruit	0	0.05, 0.08
		3	1.9 lb/gal SC	0.5	Whole fruit	0	0.58, 0.74
						6	0.62, 0.63
						14	0.63, 0.83
					Peeled fruit	0	0.05, 0.07
					Washed fruit	0	1.1, 0.07
		4	1.9 lb/gal SC	0.5	Whole fruit	0	0.38, 0.53
						6	0.45, 0.58
						14	0.44, 0.60
					Peeled fruit	0	0.04, 0.05
					Washed fruit	0	0.16, 0.13
		5	1.9 lb/gal SC	1.0	Whole fruit	0	0.84, 0.86
						6	0.68, 0.71
						14	0.63, 0.20
					Peeled fruit	0	0.04, 0.06
					Washed fruit	0	0.19, 0.16
		6	50% WP	0.5	Whole fruit	0	0.63, 0.85
					Peeled fruit	0	0.03, 0.07
		7	50% WP	1.0	Whole fruit	0	1.0, 0.90
					Peeled fruit	0	0.05, 0.11
					Washed fruit	0	0.06, 0.19

TABLE C.3. Residue Data from Citrus Post-harvest Trials with Fludioxonil (SC or WP).

Trial ID (City, State; Year)	Type (Variety)	Trt#	Formulation	Total Rate (lb ai)[1]	Commodity	Post-treatment Interval (days)	Fludioxonil Residues (ppm)[2]
Visalia, CA; 2004 5276	Orange (Valencia)	2	1.9 lb/gal SC	0.5	Whole fruit	0	0.85, 1.1
					Peeled fruit	0	0.08, 0.06
		3	1.9 lb/gal SC	0.5	Whole fruit	0	0.37, 0.50
						8	0.35, 0.50
						15	0.46, 0.51
					Peeled fruit	0	<0.02, <0.02
					Washed fruit	0	0.27, 0.35
		4	1.9 lb/gal SC	0.5	Whole fruit	0	0.32, 0.33
						8	0.34, 0.33
						15	0.35, 0.40
					Peeled fruit	0	0.02, <0.02
					Washed fruit	0	0.18, 0.21
		5	1.9 lb/gal SC	1.0	Whole fruit	0	0.75, 0.77
						8	0.53, 0.57
						15	0.72, 0.52
					Peeled fruit	0	0.03, 0.04
					Washed fruit	0	0.39, 0.47
		6	50% WP	0.5	Whole fruit	0	0.82, 0.62
					Peeled fruit	0	0.07, 0.08
Visalia, CA; 2004 5277	Grapefruit (Marsh)	2	1.9 lb/gal SC	0.5	Whole fruit	0	0.60, 0.72
					Peeled fruit	0	0.04, 0.05
		3	1.9 lb/gal SC	0.5	Whole fruit	0	0.67, 0.66
					Peeled fruit	0	0.03, 0.04
					Washed fruit	0	0.25, 0.38
		4	1.9 lb/gal SC	0.5	Whole fruit	0	0.25, 0.34
					Peeled fruit	0	<0.02, 0.03
					Washed fruit	0	0.23, 0.20
		5	1.9 lb/gal SC	1.0	Whole fruit	0	0.47, 0.59
					Peeled fruit	0	0.02, 0.03
					Washed fruit	0	0.43, 0.43
		6	50% WP	0.5	Whole fruit	0	0.90, 0.92
					Peeled fruit	0	0.04, 0.03
					Washed fruit	0	0.58, 0.52
		7	50% WP	1.0	Whole fruit	0	1.5, 1.5
					Peeled fruit	0	0.09, 0.09
					Washed fruit	0	0.58, 0.52
Mercedes, TX 2004 5278	Grapefruit (Marsh)	2	1.9 lb/gal SC	0.5	Whole fruit	0	0.78, 0.95
					Peeled fruit	0	<0.02, <0.02
		3	1.9 lb/gal SC	0.5	Whole fruit	0	0.07, 0.16
					Peeled fruit	0	<0.02, <0.02
					Washed fruit	0	<0.02, <0.02
		4	1.9 lb/gal SC	0.5	Whole fruit	0	0.25, 0.14
					Peeled fruit	0	<0.02, <0.02
					Washed fruit	0	0.16, 0.29
		5	1.9 lb/gal SC	1.0	Whole fruit	0	0.17, 0.19
					Peeled fruit	0	<0.02, <0.02
					Washed fruit	0	0.14, 0.13
		6	50% WP	0.5	Whole fruit	0	0.05, 0.08
					Peeled fruit	0	<0.02, <0.02

[1] Application rates are expressed in lb ai/100 gallons for dip and drench type applications and in lb ai/ 250,000 lb fruit for the low-volume (LV) type application.

[2] The validated method LOQ is 0.02 ppm.

TABLE C.4.1. Summary of Residue Data from Post-harvest Orange Trials with Fludioxonil (SC or WP).

Commodity	Treatment type (formulation)	PTI (days)	Total Rate (lb ai)[1]	Residue Levels (ppm)[2]						
				n	Min.	Max.	HAFT[3]	Median	Mean	Std. Dev.
Whole fruit	Dip (1.9 lb/gal SC)	0	0.5	4	0.70	1.10	0.98	0.93	0.91	0.18
Peeled fruit				4	0.05	0.08	0.07	0.07	0.07	0.02
Whole fruit	Low volume (1.9 lb/gal SC)	0	0.5	4	0.37	0.74	0.66	0.54	0.55	0.15
Peeled fruit				4	<0.02	0.07	0.06	0.03	0.04	0.03
Washed fruit				4	0.07	1.10	0.59	0.31	0.45	0.45
Whole fruit	Drench + LV (1.9 lb/gal SC)	0	0.5	4	0.32	0.53	0.46	0.36	0.39	0.10
Peeled fruit				4	<0.02	0.05	0.05	0.03	0.03	0.02
Washed fruit				4	0.13	0.21	0.20	0.17	0.17	0.03
Whole fruit	Drench + LV (1.9 lb/gal SC)	0	1.0	4	0.75	0.86	0.85	0.81	0.81	0.05
Peeled fruit				4	0.03	0.06	0.05	0.04	0.04	0.01
Washed fruit				4	0.16	0.47	0.43	0.29	0.30	0.15
Whole fruit	Low volume (50% WP)	0	0.5	4	0.62	0.85	0.74	0.73	0.73	0.12
Peeled fruit				4	0.03	0.08	0.08	0.07	0.06	0.02
Whole fruit	Low volume (50% WP)	0	1.0	2	0.90	1.00	0.95	0.95	0.95	0.07
Peeled fruit				2	0.05	0.11	0.08	0.08	0.08	0.04
Washed fruit				2	0.06	0.19	0.13	0.13	0.13	0.09

[1] Application rates are expressed in lb ai/100 gallons for dip and drench type applications and in lb ai/ 250,000 lb fruit for the low-volume (LV) type application.
[2] The validated method LOQ is 0.02 ppm for fludioxonil. For calculation of the median, mean and standard deviation, ½LOQ (0.01 ppm) was used for samples with residues <LOQ.
[3] HAFT = Highest-Average Field Trial.

TABLE C.4.2. Summary of Residue Data from Post-harvest Grapefruit Trials with Fludioxonil (SC or WP).

Commodity	Treatment type (formulation)	PTI (days)	Total Rate (lb ai)[1]	Residue Levels (ppm)[2]						
				n	Min.	Max.	HAFT[3]	Median	Mean	Std. Dev.
Whole fruit	Dip (1.9 lb/gal SC)	0	0.5	4	0.60	0.95	0.87	0.75	0.76	0.15
Peeled fruit				4	<0.02	0.05	0.05	0.03	0.03	0.02
Whole fruit	Low volume (1.9 lb/gal SC)	0	0.5	4	0.07	0.67	0.67	0.41	0.39	0.32
Peeled fruit				4	<0.02	0.04	0.04	0.02	0.02	0.02
Washed fruit				4	<0.02	0.38	0.32	0.13	0.16	0.18
Whole fruit	Drench + LV (1.9 lb/gal SC)	0	0.5	4	0.14	0.34	0.30	0.25	0.25	0.08
Peeled fruit				4	<0.02	0.03	0.02	0.01	0.02	0.01
Washed fruit				4	0.16	0.29	0.23	0.22	0.22	0.05
Whole fruit	Drench + LV (1.9 lb/gal SC)	0	1.0	4	0.17	0.59	0.53	0.33	0.36	0.21
Peeled fruit				4	<0.02	0.03	0.03	0.02	0.02	0.01
Washed fruit				4	0.13	0.43	0.43	0.29	0.28	0.17
Whole fruit	Low volume (50% WP)	0	0.5	4	0.05	0.92	0.91	0.49	0.49	0.49
Peeled fruit				4	<0.02	0.04	0.04	0.02	0.02	0.02
Whole fruit	Low volume (50% WP)	0	1.0	2	1.50	1.50	1.50	1.50	1.50	0.00
Peeled fruit				2	0.09	0.09	0.09	0.09	0.09	0.00
Washed fruit				2	0.52	0.58	0.55	0.55	0.55	0.04

[1] Application rates are expressed in lb ai/100 gallons for dip and drench type applications and in lb ai/ 250,000 lb fruit for the low-volume (LV) type application.
[2] The validated method LOQ is 0.02 ppm for fludioxonil. For calculation of the median, mean and standard deviation, ½LOQ (0.01 ppm) was used for samples with residues <LOQ.
[3] HAFT = Highest-Average Field Trial.

TABLE C.4.3. Summary of Residue Decline Data from Oranges Held in Refrigerated (7 °C) Storage after Treatment with Fludioxonil (SC).

Commodity	Treatment Type	PTI (days)	Total Rate (lb ai)[1]	Residue Levels (ppm)[2]						
				n	Min.	Max.	HAFT[3]	Median	Mean	Std. Dev.
Whole fruit	Dip (1.9 lb/gal SC)	0	0.5	4	0.37	0.74	0.66	0.54	0.55	0.15
		6-8		4	0.35	0.63	0.63	0.56	0.53	0.13
		14-15		4	0.46	0.83	0.73	0.57	0.61	0.16
	Low volume (1.9 lb/gal SC)	0	0.5	4	0.32	0.53	0.46	0.36	0.39	0.10
		6-8		4	0.33	0.58	0.52	0.40	0.43	0.12
		14-15		4	0.35	0.60	0.52	0.42	0.45	0.11
	Drench + LV (1.9 lb/gal SC)	0	1.0	4	0.75	0.86	0.85	0.81	0.81	0.05
		6-8		4	0.53	0.71	0.70	0.63	0.62	0.09
		14-15		4	0.20	0.72	0.62	0.57	0.52	0.23

[1] Application rates are expressed in lb ai/100 gallons for dip and drench type applications and in lb ai/ 250,000 lb fruit for the low-volume (LV) type application.
[2] The LOQ is 0.02 ppm.
[3] HAFT = Highest Average Field Trial.

D. CONCLUSION

The orange and grapefruit post-harvest trial data are adequate and will support the post-harvest use of the 1.9 lb/gal SC formulation on oranges and grapefruit as a single dip at 0.5 lb ai/100 gal or low-volume application at 0.5 lb ai/250,000 lb fruit, or combined drench and low-volume applications at total rates up to 1.0 lb ai (0.5 lb ai/100 gal + 0.5 lb ai/250,000 lb fruit). These data will also support use of the WP formulation as a single low-volume application at up to 1.0 lb ai, and the inclusion of a commercial finishing wax in the treatment solution.

E. REFERENCES

None

F. DOCUMENT TRACKING

RDI: RAB1 Chemists (11/1/06)
Petition Number(s): NA
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PC Code: 071503

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Primary Evaluator — Date: 16-NOV-2006
George F. Kramer, Ph.D., Senior Chemist
Registration Action Branch (RAB1)
Health Effects Division (HED) (7509P)

Approved by — Date: 16-NOV-2006
P.V. Shah, Ph.D., Branch Senior Scientist
RAB1/HED (7509P)

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STUDY REPORT:

46715502. Ediger K. (2005) Fludioxonil-Magnitude of the Residues in or on Lemons Following Post-Harvest Applications. Lab Project Number: T006229-04. Unpublished study prepared by Syngenta Crop Protection. 170 pages.

EXECUTIVE SUMMARY:

Three post-harvest trials were conducted on lemons in CA during 2004. At each location, lemons received one to three post-harvest applications of fludioxonil, formulated as a 1.9 lb/gal suspension concentrate (SC) or a 50% wettable powder (WP). Each trial consisted of up to nine different treatments, including the control (Trt #1). The treatments using the SC formulation included: a single drench application at 0.5-0.6 lb ai/100 gal (Trt #2); a drench application at 0.5-0.6 lb ai/100 gal followed immediately by a low-volume application at 0.5 or 1.0 lb ai/250,000 fruit (Trt #3); a drench application at 0.5-0.6 lb ai/100 gal followed by 14 days of refrigerated storage and then a low-volume application at 0.5 lb ai/250,000 fruit (Trt #4); a single low-volume application at 0.5 or 1.0 lb ai/250,000 fruits (Trt #5); and two sequential drench applications at ~0.5 and 0.25 lb ai/100 gal followed by a low-volume application at 0.5 lb ai/250,000 fruit, for a total rate of 1.3-1.4 lb ai (Trt #6). The treatments using the WP formulation were similar to Treatments 2-4 for the SC and included: a single drench application at 0.5-0.6 lb ai/100 gal (Trt #7); a drench application at 0.5-0.6 lb ai/100 gal followed immediately by a low-volume application at 0.5 or 1.0 lb ai/250,000 fruit (Trt #8); and a drench application at 0.5-0.6 lb ai/100 gal followed by 14 days of refrigerated storage and then a low-volume application at 0.5 lb ai/250,000 fruit (Trt #9). For each of the above treatments, the initial drench application included use of a storage wax (Decco 202) and all low-volume spray applications included use of a finishing wax (DeccoLustr 400).

The lemons were allowed to dry after each application, and following the last application, duplicate treated samples were collected and immediately placed in frozen storage. Subsamples from Treatments 3, 4, 8, and 9 were also refrigerated (7 ± 8 °C) for 14 samples prior to sampling; subsamples from Treatment 7 were refrigerated for approximately 30 days prior to sampling; and subsamples from Treatments 2 and 5 were refrigerated for approximately 30, 60, and 120 days prior to sampling. In addition, selected subsamples from Treatments 2, 5 and 7 were also lightly

washed after treatment. Samples were stored frozen from collection to analysis for up to 6.4 months, an interval supported by available storage stability data.

The high-performance liquid chromatography (HPLC)/ultraviolet (UV) method (Method AG-597B) used to determine fludioxonil residues in/on lemons is the current tolerance enforcement method for plants and was adequately validated in conjunction with the analysis of treated samples. For this method, residues are extracted with acetonitrile (ACN):water, filtered, concentrated, and partitioned into methyl tert-butyl ethyl (MTBE). Residues are then solvent exchanged into toluene and cleaned up using silica and phenyl solid-phase extraction (SPE) cartridges. Purified residues are then analyzed by HPLC/UV using a normal-phase amino column with a mobile phase of hexane:methanol: isopropyl alcohol. The validated limit of quantitation (LOQ) is 0.02 ppm, and the limit of detection (LOD) was estimated to be ~0.01 ppm, based on the lowest standard injected.

Immediately following a single drench application of fludioxonil at 0.5-0.57 lb ai/100 gal, residues in/on lemons were 0.80-1.2 ppm for the SC formulation(Trt #2) and 0.8-1.1 ppm for the WP formulation (Trt #7), and average residues for these treatments were 0.97 and 0.94 ppm, respectively. Following a combined drench application and low-volume application of fludioxonil at a total rate of 1.0-1.6 lb ai, residues in/on lemons were 1.9-3.9 ppm for the SC formulation and 2.0-2.5 ppm for the WP formulation (Trts #3 and #8), and average residues for these treatments were 2.93 and 2.18 ppm. respectively. Following a combined drench and low-volume application of fludioxonil at a total rate of 1.0-1.1 lb ai, with a 14-day retreatment interval (RTI) between applications, residues in/on lemons were 1.2-1.3 ppm for the SC formulation and 1.3-1.7 ppm for the WP formulation (Trts #4 and #9), and average residues for these treatments were 1.28 and 1.55 ppm, respectively. These paired treatments indicate that residues in/on lemons were similar for the two formulations, and that the highest residue levels occur following the combined drench and low-volume spray applications made on the same day (Trt #4 and #8).

For the other treatments using the SC formulation, residues in/on lemons sampled immediately following a single low-volume spray application at 0.5 or 1.0 lb ai/250,000 fruit (Trt #5) were 0.93-1.7 ppm and averaged 1.25 ppm. Residues in/on lemons sampled immediately following the last of two drench applications and a single low-volume spray application at rates totaling 1.3-1.4 lb ai (Trt #6) were 1.1-2.8 ppm and averaged 1.90 ppm.

Refrigerated storage for up to 4 months had no affect on residues in/on treated lemons, but washing of treated lemons reduced average residues by 29-71%.

STUDY/WAIVER ACCEPTABILITY/DEFICIENCIES/CLARIFICATIONS:

Under the conditions and parameters used in the study, the post-harvest trial residue data on lemons are classified as scientifically acceptable. The acceptability of this study for regulatory purposes is addressed in the forthcoming U.S. EPA Residue Chemistry Summary Document [DP# 325160].

COMPLIANCE:

Signed and dated Good Laboratory Practice (GLP), Quality Assurance and Data Confidentiality statements were provided. The study author cited deviations from GLP compliance that included gross sample weight determinations and field history which were not collected according to GLP guidelines, and application solution data were not generated as required in 40 CFR part 160.113(a)(1) and (3). Sampling dates for field trial 5280 were also not recorded according to GLP. One trial reported higher than target application rates, with no explanation. This misapplication did not appear to cause higher residue levels.

A. BACKGROUND INFORMATION

Fludioxonil is a contact fungicide, which inhibits protein kinase, leading to reduced fungal growth and development. Tolerances are currently established for residues of fludioxonil, 4-(2,2-difluoro-1,3-benzodioxol-4-yl)-1*H*-pyrrole-3-carbonitrile, in/on various plant commodities at levels ranging from 0.01-500 ppm [40 CFR § 180.516], including a 10 ppm tolerance for the citrus fruit crop group.

TABLE A.1. Fludioxonil Nomenclature.

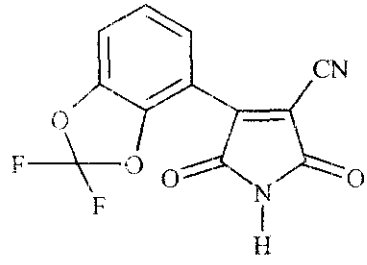
Compound	
Common name	Fludioxonil
Company experimental name	CGA-173506
IUPAC name	4-(2,2-difluoro-1,3-benzodioxol-4-yl)-*1H*-pyrrole-3-carbonitrile
CAS name	4-(2,2-difluoro-1,3-benzodioxol-4-yl)-*1H*-pyrrole-3-carbonitrile
CAS registry number	131341-86-1
End-use products (EP)	Scholar® Fungicide (50% WP; EPA Reg. No. 100-969) Scholar® Fungicide (1.9 lb/gal SC; EPA Reg. No. 100-###)

TABLE A.2. Physicochemical Properties of Fludioxonil.

Parameter	Value	Reference
Melting point	199.8 °C	Provided in this study
pH	8-9 @ 25 °C (1% aqueous Dispersion)	
Density	1.54 g/cm^3 typical at 23 °C	
Water solubility (25 °C)	1.8 mg/L	
Solvent solubility (mg/L @ 25 °C)	Ethanol 44,000 Acetone 190,000 Toluene 2,700 n-Octanol 20,000 n-Hexane 7.8	
Vapor pressure (25 °C)	2.9 x 10^{-9} mm Hg	
Dissociation constant, pK_a	pK_{a1} <0 pK_{a2} ~ 14.1	
Octanol/water partition coefficient, Log(K_{OW})	4.12 @ 25 °C	

TABLE A.2. Physicochemical Properties of Fludioxonil.		
Parameter	Value	Reference
UV/visible absorption spectrum	12,384 l/mol x cm @266 nm (neutral solution) 12,327 l/mol x cm @ 265 nm (acidic solution) 11,790 l/mol x cm @ 271 nm (basic solution)	

B. EXPERIMENTAL DESIGN

B.1. Study Site Information

The untreated lemons used for post-harvest treatments were obtained from commercial or research orchards. As applications were made post-harvest at indoor facilities, variables such as soil type, length of growing season and weather are not relevant to the current study.

Fludioxonil (SC or WP) was applied to lemons as one, two or three post-harvest applications using drench and/or low-volume spray applications (Table B.1.1). The drench applications were made using a packing line equipped with a recirculating drench, and the low-volume spray applications were made using a packing line equipped with either controlled-droplet applicators or a rollerbed with spray nozzles. With the exceptions of two treatments (Trts #4 and #9) in which lemons were refrigerated for 14 days between applications, all applications for each treatment were made on the same day. The initial drench application in each treatment included a storage wax (Decco 202) and all low-volume spray applications included a finishing wax (DeccoLustr 400) at the label recommended rates.

TABLE B.1.1. Study Use Pattern on Lemon: Post-harvest Application of Fludioxonil (SC or WP).							
Location (City, State; Year) Trial ID	Post-harvest Applications						
	TRT #	Formulation	Method; Timing	Single Rates (lb ai)[1]	RTI[2] (days)	Total rate (lb ai)[1]	Additives[3]
Parlier, CA 2004 5280	2	1.9 lb/gal SC	Single drench application	0.57	NA	0.57	Wax
	3	1.9 lb/gal SC	drench + low-volume application	0.57 + 1.0	0	1.57	Wax
	4	1.9 lb/gal SC	drench + low-volume application	0.57 + 0.5	14[4]	1.07	Wax
	5	1.9 lb/gal SC	Single low-volume application	1.0	NA	1.0	Wax
	6	1.9 lb/gal SC	Two drenches + one low-volume application	0.57 + 0.29 + 0.5	0	1.36	Wax
	7	50% WP	Single drench application	0.5	NA	0.5	Wax
	8	50% WP	drench + low-volume application	0.5 + 1.0	0	1.5	Wax
	9	50% WP	drench + low-volume application	0.5 + 0.5	14[4]	1.0	Wax

TABLE B.1.1. Study Use Pattern on Lemon: Post-harvest Application of Fludioxonil (SC or WP).

Location (City, State; Year) Trial ID	Post-harvest Applications						
	TRT #	Formulation	Method; Timing	Single Rates (lb ai)[1]	RTI[2] (days)	Total rate (lb ai)[1]	Additives[3]
Visalia, CA 2004 5281	2	1.9 lb/gal SC	Single drench application	0.5	NA	0.5	Wax
	3	1.9 lb/gal SC	drench + low-volume application	0.5 + 0.5	0	1.0	Wax
	4	1.9 lb/gal SC	drench + low-volume application	0.5 + 0.5	14[4]	1.0	Wax
	5	1.9 lb/gal SC	Single low-volume application	0.5	NA	0.5	Wax
	6	1.9 lb/gal SC	Two drenches + one low-volume application	0.5 + 0.25 + 0.5	0	1.25	Wax
	7	50% WP	Single drench application	0.5	NA	0.5	Wax
	8	50% WP	drench + low-volume application	0.5 + 0.5	0	1.0	Wax
	9	50% WP	drench + low-volume application	0.5 + 0.5	14[4]	1.0	Wax
Parlier, CA 2004 5282	3	1.9 lb/gal SC	drench + low-volume application	0.5 + 0.5	0	1.0	Wax
	5	1.9 lb/gal SC	Single low-volume application	0.5	NA	0.5	Wax
	6	1.9 lb/gal SC	Two drench + one low-volume application	0.5 + 0.25 + 0.5	0	1.25	Wax

[1] Rates are expressed in lb ai/100 gallons for the drench applications and in lb ai/250,000 fruit for the low-volume application.
[2] RTI = retreatment interval.
[3] The Initial drench application in each treatment included a storage wax (Decco 202) and all low-volume spray applications included a finishing wax (Decco Lustr 400).
[4] Fruit were stored under refrigeration for 14 days between the first and second applications.

B.2. Sample Handling and Preparation

The fruit was allowed to dry after each application and duplicate treated samples were collected from each treatment and placed in frozen storage on the day of the last treatment. After collection, selected subsamples from Treatments 2, 5 and 7 were also washed by gently rubbing the fruit by hand under running water for ~10 seconds. In addition, subsamples from Treatments 2 and 5 from two trials were refrigerated (7 ± 8 °C) for approximately 30, 60, and 120 days prior to sampling in order to examine residue decline under normal refrigeration conditions. Subsamples from Treatments 3, 4, 8, and 9 were also refrigerated for 14 samples prior to sampling, and subsamples from Treatment 7 were refrigerated for approximately 30 days prior to sampling. All samples were shipped frozen to Syngenta Corp Protection, Inc., Greensboro, NC for sample preparation, where samples were stored at -20 °C. For analysis, the prepared samples were later shipped frozen to EN-CAS Laboratories, Winston-Salem, NC, where samples were stored at ~20 °C.

B.3. Analytical Methodology

Lemon samples were analyzed using an HPLC/UV method (Method AG-597B), "Analytical Method for the Determination of CGA-173506 in Crops by High Performance Liquid Chromatography Including Validation Data." This method is the current tolerance enforcement method for determining fludioxonil in plant commodities.

For this method, residues are extracted with ACN:water (90:10, v/v), filtered, and concentrated to remove the ACN. Residues were diluted with a saturated salt solution and partitioned into MTBE. Residues were then solvent exchanged into toluene, diluted with hexane, and cleaned up using a silica SPE cartridge eluted with toluene:dichloromethane (1:1, v/v). Residues were next concentrated to dryness, reconstituted in methanol:water, and further purified using a phenyl SPE cartridge eluted with acetone. Purified residues were concentrated, reconstituted in the HPLC mobile phase, hexane:methanol:isopropyl alcohol (90:6:6, v/v/v), and analyzed by HPLC/UV at 268 nm using a normal phase amino column and external standards. The LOQ is 0.02 ppm, and the LOD was defined as the lowest standard injected (1 ng), which is equivalent to ~0.01 ppm based on peak areas.

In conjunction with the analysis of trial samples, the above method was validated using control samples of lemons fortified with fludioxonil at 0.02-5.0 ppm.

C. RESULTS AND DISCUSSION

The number of lemon post-harvest trials is adequate, and geographic representation of the residue data is not relevant as the proposed use is for post-harvest application in fruit packing houses. A total of three post-harvest trials were conducted in which lemons received one to three post-harvest applications of fludioxonil, formulated as a 1.9 lb/gal SC or 50% WP. Each trial consisted of three or nine different treatments, including a control (Trt #1). The treatments using the SC formulation included: a single drench application at 0.5-0.6 lb ai/100 gal (Trt #2); a drench application at 0.5-0.6 lb ai/100 gal followed immediately by a low-volume application at 0.5 or 1.0 lb ai/250,000 fruit (Trt #3); a drench application at 0.5-0.6 lb ai/100 gal followed by 14 days of refrigerated storage and then a low-volume application at 0.5 lb ai/250,000 fruit (Trt #4); a single low-volume spray application at 0.5 or 1.0 lb ai/250,000 fruits (Trt #5); and two sequential drench applications at ~0.5 and 0.25 lb ai/100 gal followed by a low-volume application at 0.5 lb ai/250,000 fruit, for a total rate of 1.3-1.4 lb ai (Trt #6). The treatments using the WP formulation were similar to Treatments 2-4 and included: a single drench application at 0.5-0.6 lb ai/100 gal (Trt #7); a drench application at 0.5-0.6 lb ai/100 gal followed immediately by a low-volume application at 0.5 or 1.0 lb ai/250,000 fruit (Trt #8); and a drench application at 0.5-0.6 lb ai/100 gal followed by 14 days of refrigerated storage and then a low-volume application at 0.5 lb ai/250,000 fruit (Trt #9).

The lemons were allowed to dry after each application, and following the last application, duplicate treated samples were collected and immediately placed in frozen storage. Subsamples from Treatments 3, 4, 8, and 9 were also refrigerated (7 ± 8 °C) for 14 samples prior to sampling; subsamples from Treatment 7 were refrigerated for approximately 30 days prior to sampling; and subsamples from Treatments 2 and 5 were refrigerated for approximately 30, 60, and 120 days prior to sampling. In addition, selected subsamples from Treatments 2, 5 and 7 were also lightly washed.

The HPLC/UV method (Method AG-597B) used to determine fludioxonil residues in/on lemon samples was adequately validated in conjunction with the field sample analyses. Concurrent method recoveries were 112 and 92% from the single samples fortified at 0.02 or 5.0 ppm. At

the remaining fortification levels (0.2-1.0 ppm), recoveries averaged 86-95% (±9-13%). Apparent residues of fludioxonil was <LOQ in/on all control samples. The validated method LOQ is 0.02 ppm and the estimated LOD is ~0.01 ppm. Adequate sample calculations and example chromatograms were provided.

Lemon samples were stored for up to 6.4 months prior to extraction for analysis (Table C.2.). The study authors cited storage stability data indicating that fludioxonil is stable at -20 °C for at least 13.8 months in whole citrus fruit and 9.4 months in citrus juice. These data will support the frozen storage intervals in the current trials.

Immediately following a single drench application of fludioxonil at 0.5-0.57 lb ai/100 gal, residues in/on lemons were 0.80-1.2 ppm for the SC formulation and 0.8-1.1 ppm for the WP formulation (Trts #2 and #7, Table C.3), and average residues for these treatments were 0.97 and 0.94 ppm, respectively (Table C.4.1). Following a combined drench application and low-volume application of fludioxonil at a total rate of 1.0-1.6 lb ai, residues in/on lemons were 1.9-3.9 ppm for the SC formulation and 2.0-2.5 ppm for the WP formulation (Trts #3 and #8), and average residues for these treatments were 2.93 and 2.18 ppm, respectively. Following a combined drench and low-volume application of fludioxonil at a total rate of 1.0-1.1 lb ai, with a 14-day RTI between applications, residues in/on lemons were 1.2-1.3 ppm for the SC formulation and 1.3-1.7 ppm for the WP formulation (Trts #4 and #9), and average residues for these treatments were 1.28 and 1.55 ppm, respectively. The above paired treatments indicate that residues in/on lemons were similar for the two formulations, and that the highest residue levels occur following the combined drench and low-volume spray applications made on the same day (Trt #4 and #8).

For the other treatments using the SC formulation, residues in/on lemons sampled immediately following a single low-volume spray application at 0.5 or 1.0 lb ai/250,000 fruit (Trt #5) were 0.93-1.7 ppm and averaged 1.25 ppm. Residues in/on lemons sampled immediately following the last of two drench applications and a single low-volume spray application at rates totaling 1.3-1.4 lb ai (Trt #6) were 1.1-2.8 ppm and averaged 1.90 ppm.

For the treatments that included subsamples of washed fruit, washing of treated lemons reduced average residues by 29-71% (Table C.4.1). Refrigerated storage of treated lemons had no apparent affect on residues at storage intervals up to 4 months (Table C.4.2).

TABLE C.[illegible] Summary of Concurrent Method Recoveries of Fludioxonil from Lemons.

Analyte	Matrix	Spike level (ppm)	Sample size (n)	Recoveries (%)	Mean ± std dev (%)
Fludioxonil	Lemon	0.02	1	112	NA
		0.2	5	75, 103, 78, 81, 94	86 ± 12
		0.5	10	101, 92, 97, 92, 111, 86, 102, 94, 108, 67	95 ± 13
		1.0	7	76, 76, 94, 90, 96, 79, 91	86 ± 9
		5.0	1	92	NA
		Overall	24	67-112	91 ± 12

TABLE C.2 Summary of Storage Conditions.

Matrix	Storage Temperature (°C)	Actual Storage Duration (months)	Interval of Demonstrated Storage Stability (months)[1]
Lemons	-20	2.8-6.4	13.8

[1] MRID 46162301.

TABLE C.3. Residue Data from Lemon Post-harvest Trials with Fludioxonil (SC or WP).

Trial ID (City, State; Year)	Variety	TRT #	Formulation	Total Rate (lb ai/A)[1]	Commodity	PTI[2] (days)	Fludioxonil Residues (ppm)[3]
Parlier, CA; 2004-5280	Eureka	2	1.9 lb/gal SC	0.57	Whole Fruit	0	1.2, 1.0
						30	0.87, 0.52
						66	0.77, 0.86
						122	1.2, 1.2
					Washed Fruit	0	0.87, 0.83
						30	0.81, 0.77
						66	1.0, 1.0
						122	1.1, 0.84
		3	1.9 lb/gal SC	1.57	Whole Fruit	0	3.0, 3.9
						14	2.9, 3.2
		4	1.9 lb/gal SC	1.07	Whole Fruit	0	1.3, 1.2
						14	1.7, 1.7
		5	1.9 lb/gal SC	1.0	Whole Fruit	0	1.6, 1.7
						30	0.74, 1.4
						66	1.3, 1.1
						122	1.9, 1.5
					Washed Fruit	0	0.31, 0.47
						30	1.7, 1.9
						66	1.7, 1.5
						122	1.7, 1.3
		6	1.9 lb/gal SC	1.36	Whole Fruit	0	2.1, 1.7
						14	1.6, 1.8
		7	50% WP	0.5	Whole Fruit	0	1.1, 0.91
						30	1.1, 1.4
					Washed Fruit	0	0.55, 0.46
						30	0.90, 1.1
		8	50% WP	1.5	Whole Fruit	0	2.5, 2.0
						14	2.1, 2.1
		9	50% WP	1.0	Whole Fruit	0	1.3, 1.5
						14	1.8, 1.8

TABLE C.3. Residue Data from Lemon Post-harvest Trials with Fludioxonil (SC or WP).

Trial ID (City, State; Year)	Variety	TRT #	Formulation	Total Rate (lb ai/A)[1]	Commodity	PTI[2] (days)	Fludioxonil Residues (ppm)[3]
Visalia, CA; 2004 5281	Eureka	2	1.9 lb/gal SC	0.5	Whole Fruit	0	0.80, 0.89
						31	0.72, 0.86
						61	1.1, 1.4
						123	1.5, 1.3
					Washed Fruit	0	0.49, 0.58
						31	0.62, 0.52
						61	0.62, 0.43
						123	0.58, 0.68
		3	1.9 lb/gal SC	1.0	Whole Fruit	0	2.4, 1.9
						14	1.0, 1.1
		4	1.9 lb/gal SC	1.0	Whole Fruit	0	1.3, 1.3
						14	1.2, 1.3
		5	1.9 lb/gal SC	0.5	Whole Fruit	0	1.1, 0.93
						31	0.81, 0.92
						61	0.85, 1.5
						123	1.2, 0.81
					Washed Fruit	0	0.58, 0.50
						31	0.56, 0.67
						61	0.63, 0.66
						123	0.65, 1.0
		6	1.9 lb/gal SC	1.25	Whole Fruit	0	1.1, 1.3
						14	0.88, 0.82
		7	50% WP	0.5	Whole Fruit	0	0.94, 0.80
						31	0.86, 0.72
					Washed Fruit	0	0.54, 0.53
						31	0.44, 0.55
		8	50% WP	1.0	Whole Fruit	0	2.1, 2.1
						14	1.2, 1.5
		9	50% WP	1.0	Whole Fruit	0	1.6, 1.7
						14	1.7, 1.6
Parlier, CA; 2004 5282	Eureka	3	1.9 lb/gal SC	1.0	Whole Fruit	0	3.2, 3.2
		5	1.9 lb/gal SC	0.5	Whole Fruit	0	1.2, 0.97
					Washed Fruit	0	0.28, 0.04
		6	1.9 lb/gal SC	1.25	Whole Fruit	0	2.4, 2.8

[1] Application rates are expressed in lb ai/100 gallons for dip and drench type applications and in lb ai/ 250,000 lb fruit for the low-volume (LV) type application.
[2] PTI = post-treatment sampling interval.
[3] The LOQ is 0.02 ppm.

TABLE C.4.1. Summary of Residue Data from Lemon Post-harvest Trials with Fludioxonil (SC or WP).

Trt#	Commodity	PTI (days)	Total Rate (lb ai)[1]	Residue Levels (ppm)[2]						
				n	Min.	Max.	HAFT[3]	Median	Mean	Std. Dev.
2	Fruit	0	0.5-0.6	4	0.80	1.20	1.10	0.95	0.97	0.17
	Washed Fruit			4	0.49	0.87	0.85	0.71	0.69	0.19
3	Fruit	0	1.0-1.6	6	1.90	3.90	3.45	3.10	2.93	0.70
4	Fruit	0	1.0-1.1	4	1.20	1.30	1.30	1.30	1.28	0.05
5	Fruit	0	0.5-1.0	6	0.93	1.70	1.65	1.15	1.25	0.33
	Washed Fruit			6	0.04	0.58	0.54	0.39	0.36	0.20
6	Fruit	0	1.3-1.4	6	1.10	2.80	2.60	1.90	1.90	0.65
7	Fruit	0	0.5	4	0.80	1.10	1.01	0.93	0.94	0.12
	Washed Fruit			4	0.46	0.55	0.54	0.54	0.52	0.04
8	Fruit	0	1.0-1.5	4	2.00	2.50	2.25	2.10	2.18	0.22
9	Fruit	0	1.0	4	1.30	1.70	1.65	1.55	1.53	0.17

[1] Rates are expressed in lb ai/100 gallons for the drench applications and in lb ai/250.000 fruit for the low-volume application.
[2] The LOQ is 0.02 ppm.
[3] HAFT = Highest-Average Field Trial.

TABLE C.4.1. Summary of Residue Decline Data from Lemons Held in Refrigerated Storage (7 °C) after Treatment with Fludioxonil (SC).

Trt#	Commodity	Total Rate (lb ai) [1]	PTI (days)	Residue Levels (ppm)[2]						
				n	Min.	Max.	HAFT[3]	Median	Mean	Std. Dev.
2	Fruit	0.5-0.6	0	4	0.80	1.20	1.10	0.95	0.97	0.17
			30-31	4	0.52	0.87	0.79	0.79	0.74	0.16
			61-66	4	0.77	1.40	1.25	0.98	1.03	0.28
			122-123	4	1.20	1.50	1.40	1.25	1.30	0.14
	Washed fruit	0.5-0.6	0	4	0.49	0.87	0.85	0.71	0.69	0.19
			30-31	4	0.52	0.81	0.79	0.70	0.68	0.13
			61-66	4	0.43	1.00	1.00	0.81	0.76	0.29
			122-123	4	0.58	1.10	0.97	0.76	0.80	0.23
5	Fruit	0.5-1.0	0	4	0.93	1.70	1.65	1.35	1.33	0.38
			30-31	4	0.74	1.40	1.07	0.87	0.97	0.30
			61-66	4	0.85	1.50	1.20	1.20	1.19	0.28
			122-123	4	0.81	1.90	1.70	1.35	1.35	0.46
	Washed fruit	0.5-1.0	0	4	0.31	0.58	0.54	0.49	0.47	0.11
			30-31	4	0.56	1.90	1.80	1.19	1.21	0.69
			61-66	4	0.63	1.70	1.60	1.08	1.12	0.56
			122-123	4	0.65	1.70	1.50	1.15	1.16	0.45

[1] Rates are expressed in lb ai/100 gallons for the drench applications and in lb ai/250.000 fruit for the low-volume application.
[2] The LOQ is 0.02 ppm.
[3] HAFT = Highest-Average Field Trial.

D. CONCLUSION

The lemon post-harvest trial data are adequate and will support the post-harvest use of the 1.9 lb/gal SC and 50% WP formulations on lemons as a single drench at 0.5 lb ai/100 gal or low-volume application at 0.5 lb ai/250,000 lb fruit, or combined drench and low-volume applications at total rates up to 1.0 lb ai (0.5 lb ai/100 gal + 0.5 lb ai/250,000 lb fruit). These data also support use of commercial storage and finishing waxes in the treatment solutions.

E. REFERENCES

None

F. DOCUMENT TRACKING

RDI: RAB1 Chemists (11/1/06)
Petition Number(s): NA
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Primary Evaluator — Date: 16-NOV-2006
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This DER was originally prepared under contract by Dynamac Corporation (1910 Sedwick Rd., Building 100, Durham, NC 27713; submitted 7/31/2006). The DER has been reviewed by HED and revised to reflect current Office of Pesticide Programs (OPP) policies.

STUDY REPORT:

46715503. Ediger K. (2005) Fludioxonil-Magnitude of the Residues in or on Pome Fruits Following Post-Harvest Applications. Lab Project Number: T002778-03. Unpublished study prepared by Syngenta Crop Protection. 256 pages.

EXECUTIVE SUMMARY:

A total of eight post-harvest trials using apples and pears (4 trials each) were conducted in CA and NY during 2004. At each location, apples or pears received one or two, post-harvest applications of fludioxonil, formulated as a 1.9 lb/gal suspension concentrate (SC) or a 50% wettable powder (WP). Each trial consisted of four or six different treatments, including a control (Trt #1); a drench application using the SC formulation at 0.25 lb ai/100 gal (Trt #2); a low-volume spray application using the SC formulation at 0.25 lb ai/200,000 fruit (Trt #3); a combined application of a drench at 0.25 lb ai/100 gal followed by a rinse and a low-volume application at 0.25 lb ai/200,000 fruit using both the SC and WP formulations (Trts #4 and #5); and a single low-volume spray application using the WP formulation at 0.50 lb ai/200,000 fruit (Trt #6). All the low-volume applications included the use of a finishing wax. After the final application, fruits were allowed to dry, and duplicate treated samples were collected and placed in frozen storage. In addition, selected subsamples of apples and pears from Treatments 2, 4, and 5 were also gently washed prior to sampling. Samples were stored frozen from collection to analysis for up to 3.4 months, an interval supported by available storage stability data.

The high-performance liquid chromatography (HPLC)/ultraviolet (UV) method (Method AG-597B) used to determine fludioxonil residues in/on apples and pears is the current tolerance enforcement method for plants and was adequately validated in conjunction with the analysis of treated samples. For this method, residues are extracted with acetonitrile (ACN):water, filtered, concentrated, and partitioned into methyl tert-butyl ethyl (MTBE). Residues are then solvent exchanged into toluene and cleaned up using silica and phenyl solid-phase extraction (SPE) cartridges. Purified residues are then analyzed by HPLC/UV using a normal-phase amino column with a mobile phase of hexane:methanol: isopropyl alcohol. The validated limit of quantitation (LOQ) is 0.02 ppm, and the estimated limit of detection (LOD) was 0.013 ppm.

The distribution of residues between the various post-harvest treatments was similar for apples and pears. For the SC formulation, residues were 0.26-1.60 ppm in/on apples and 0.02-1.20 in/on pears following the single drench application at 0.25 lb ai/100 gal (Trt #2), and were 0.06-1.00 ppm in/on apples and 0.11-1.40 ppm in/on pears following a low-volume application at 0.25 lb ai/200,000 fruit (Trt #3). The highest residue levels were observed in/on apples (0.42-2.30 ppm) and pears (0.39-2.90 ppm) following the combined drench and low-volume applications of the SC formulation at a total rate of 0.5 lb ai (Trt #4). Average residues in/on apples were 0.81, 0.33, and 1.04 ppm for Treatments 2, 3 and 4, respectively, and average residues in/on pears were 0.50, 0.63, 1.23 ppm for Treatments 2, 3 and 4.

For the WP formulation, residues were 0.39-0.73 ppm in/on apples and 0.42-0.97 ppm in/on pears following the combined drench and low-volume applications at a total rate of 0.5 lb ai (Trt# 5); and residues were 0.05-051 ppm in/on apples and 0.12-1.60 in/on pears following the single low-volume application at 0.5 lb ai/100 gal (Trt #6). Average residues for Treatment 5 and 6 were 0.52 and 0.19 ppm in/on apples and 0.67 and 0.54 ppm in/on pears. For the same type of treatment (Trts #4 and #5), residues from the WP formulation were slightly lower than from the SC formulation.

Comparing average residues in/on unwashed and washed fruits within each trial indicates that mild washing with water reduced residues by an average of 49%.

STUDY/WAIVER ACCEPTABILITY/DEFICIENCIES/CLARIFICATIONS:

Under the conditions and parameters used in the study, the post-harvest residue data on pome fruits are classified as scientifically acceptable. The acceptability of this study for regulatory purposes is addressed in the forthcoming U.S. EPA Residue Chemistry Summary Document [DP# 325160].

COMPLIANCE:

Signed and dated Good Laboratory Practice (GLP), Quality Assurance and Data Confidentiality statements were provided. The study author cited deviations from GLP compliance that included gross sample weight determinations and field history which were not collected according to GLP guidelines, and application solution data were not generated as required in 40 CFR part 160.113(a)(1) and (3). None of these deviations affect the acceptability of the study.

A. BACKGROUND INFORMATION

Fludioxonil is a contact fungicide, which inhibits protein kinase, leading to reduced fungal growth and development. Tolerances are currently established for residues of fludioxonil, 4-(2,2-difluoro-1,3-benzodioxol-4-yl)-1*H*-pyrrole-3-carbonitrile, in/on various plant commodities at levels ranging from 0.01-500 ppm [40 CFR §180.516], including a 5 ppm tolerance for the pome fruit crop group.

TABLE A.1. Fludioxonil Nomenclature.

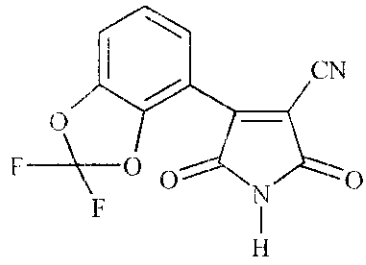
Compound	
Common name	Fludioxonil
Company experimental name	CGA-173506
IUPAC name	4-(2,2-difluoro-1,3-benzodioxol-4-yl)-*1H*-pyrrole-3-carbonitrile
CAS name	4-(2,2-difluoro-1,3-benzodioxol-4-yl)-*1H*-pyrrole-3-carbonitrile
CAS registry number	131341-86-1
End-use products (EP)	Scholar® Fungicide (50% WP; EPA Reg. No. 100-969) Scholar® Fungicide (1.9 lb/gal SC; EPA Reg. No. 100-###)

TABLE A.2. Physicochemical Properties of Fludioxonil.

Parameter	Value	Reference
Melting point	199.8 °C	Provided in this study
pH	8-9 @ 25 °C (1% aqueous Dispersion)	
Density	1.54 g/cm^3 typical at 23 °C	
Water solubility (25 °C)	1.8 mg/L	
Solvent solubility (mg/L @ 25 °C)	Ethanol 44,000 Acetone 190,000 Toluene 2,700 n-Octanol 20,000 n-Hexane 7.8	
Vapor pressure (25 °C)	2.9 x 10^{-9} mm Hg	
Dissociation constant, pK_a	pK_{a1} <0 pK_{a2} ~ 14.1	
Octanol/water partition coefficient, Log(K_{OW})	4.12 @ 25 °C	
UV/visible absorption spectrum	12,384 l/mol x cm @266 nm (neutral solution) 12,327 l/mol x cm @ 265 nm (acidic solution) 11,790 l/mol x cm @ 271 nm (basic solution)	

B. EXPERIMENTAL DESIGN

B.1. Study Site Information

The untreated apples and pears used for post-harvest treatments were obtained from commercial or research orchards. As applications were made post-harvest at indoor facilities, variables such as soil type, length of growing season and weather are not relevant to the current study.

Fludioxonil (SC or WP) was applied to apples or pears as one or two post-harvest applications using drench and/or low-volume spray applications (Table B.1.1). The drench applications were made by pouring the treatment solution over the fruits on a packing line, and the low-volume applications were made using a packing line equipped with controlled-droplet applicators, brushes, belts, rollers, wig-wag or dribble applicators. For the combined drench plus low-volume applications, fruit were washed by dipping in clean water (30 sec.) between treatments;

all applications were made on the same day. All low-volume spray applications included a finishing wax at the rates recommend on the label for the fruit wax.

TABLE B.1.1. Study Use Pattern on Pome Fruits: Post-harvest Application of Fludioxonil (SC or WP).

Location (City, State; Year) Trial ID	Post-harvest Application					
	Trt#	Formulation	Method; Timing	Single Rate (lb ai)[1]	Total rate (lb ai)	Additives[2]
Apples Trials						
Visalia, CA 2004 5300	2	1.9 lb/gal SC	Single drench application	0.25	0.25	--
	3		Single low-volume application	0.25	0.25	Wax
	4[3]		Drench application, w/ wash, plus low-volume application	0.25 – 0.25	0.50	Wax
	5[3]	50% WP	Drench application, w/ wash, plus low-volume application	0.25 + 0.25	0.50	Wax
	6		Single low-volume application	0.50	0.50	Wax
Hudson, NY 2004 5301	2	1.9 lb/gal SC	Single drench application	0.25	0.25	--
	3		Single low-volume application	0.25	0.25	Wax
	4[3]		Drench application, w/ wash, plus low-volume application	0.25 + 0.25	0.50	Wax
	5[3]	50% WP	Drench application, w/ wash, plus low-volume application	0.25 + 0.25	0.50	Wax
	6		Single low-volume application	0.50	0.50	Wax
Parlier, CA 2004 5302	2	1.9 lb/gal SC	Single drench application	0.25	0.25	--
	3		Single low-volume application	0.25	0.25	Wax
	4[3]		Drench application, w/ wash, and low-volume application	0.25 + 0.25	0.50	Wax
Hudson, NY 2004 5303	2	1.9 lb/gal SC	Single drench application	0.25	0.25	--
	3		Single low-volume application	0.25	0.25	Wax
	4[3]		Drench application, w/ wash, plus low-volume application	0.25 + 0.25	0.50	Wax
Pears Trials						
Visalia, CA 2004 5304	2	1.9 lb/gal SC	Single drench application	0.25	0.25	--
	3		Single low-volume application	0.25	0.25	Wax
	4[3]		Drench application, w/ wash, plus low-volume application	0.25 + 0.25	0.50	Wax
	5[3]	50% WP	Drench application, w/ wash, plus low-volume application	0.25 + 0.25	0.50	Wax
	6		Single low-volume application	0.50	0.50	Wax
Hudson, NY 2004 5305	2	1.9 lb/gal SC	Single drench application	0.25	0.25	--
	3		Single low-volume application	0.25	0.25	Wax
	4[3]		Drench application, w/ wash, plus low-volume application	0.25 + 0.25	0.50	Wax
	5[3]	50% WP	Drench application, w/ wash, plus low-volume application	0.25 + 0.25	0.50	Wax
	6		Single low-volume application	0.50	0.50	Wax
Parlier, Ca 2004 5306	2	1.9 lb/gal SC	Single drench application	0.25	0.25	--
	3		Single low-volume application	0.25	0.25	Wax
	4[3]		Drench application, w/ wash, plus low-volume application	0.25 – 0.25	0.50	Wax
Hudson, NY 2004 5307	2	1.9 lb/gal SC	Single drench application	0.25	0.25	--
	3		Single low-volume application	0.25	0.25	Wax
	4[3]		Drench application, w/ wash, plus low-volume application	0.25 + 0.25	0.50	Wax

[1] Rates are expressed in lb ai/100 gallons for the drench applications and in lb ai/200,000 fruit for the low-volume application.
[2] A Finishing wax (Sta-Fresh, APL Lustr 231, or Prima Fresh Ultra 975) was included in each low-volume spray.
[3] For combined drench + low-volume application, fruit were washed (dipped) in water between treatments.

B.2. Sample Handling and Preparation

Fruits were allowed to dry after the final application, and duplicate treated samples were collected from each treatment and placed in frozen storage on the day of treatment. In addition, selected subsamples from Treatments 2, 4, and 5 from two apple and two pear trial sites were washed by gently rubbing the fruit by hand under running water for ~10 seconds. All samples were shipped frozen to Syngenta Corp Protection, Inc., Greensboro, NC for sample preparation, where samples were stored at -20 °C. For analysis, the prepared samples were later shipped frozen to Enviro-Test Laboratories, Edmonton, Alberta, where samples were stored at <-20 °C.

B.3. Analytical Methodology

Apple and pear samples were analyzed using an HPLC/UV method (Method AG-597B), "Analytical Method for the Determination of CGA-173506 in Crops by High Performance Liquid Chromatography Including Validation Data." This method is the current tolerance enforcement method for determining fludioxonil in plant commodities.

For this method, residues are extracted with ACN:water (90:10, v/v), filtered, and concentrated to remove the ACN. Residues were diluted with a saturated salt solution and partitioned into MTBE. Residues were then solvent exchanged into toluene, diluted with hexane, and cleaned up using a silica SPE cartridge eluted with toluene:dichloromethane (1:1, v/v). Residues were next concentrated to dryness, reconstituted in methanol:water, and further purified using a phenyl SPE cartridge eluted with acetone. Purified residues were concentrated, reconstituted in the HPLC mobile phase, hexane:methanol:isopropyl alcohol (90:6:6, v/v/v), and analyzed by HPLC/UV at 268 nm using a normal phase amino column and external standards. The LOQ is 0.02 ppm, and the estimated LOD was 0.013 ppm.

In conjunction with the analysis of field trial samples, the above method was validated using control samples of apples and pears fortified with fludioxonil at 0.02-2.0 ppm.

C. RESULTS AND DISCUSSION

The number of apple and pear post-harvest trials is adequate, and geographic representation of the residue data is not relevant as the proposed use is for post-harvest applications in fruit packing houses. A total of eight post-harvest trials were conducted in which apples or pears (4 trials each) received a post-harvest application of fludioxonil, formulated as a 1.9 lb/gal SC or 50% WP. Each trial consisted of four or six different treatments, including a control (Trt #1); a single drench application using the SC formulation at 0.25 lb ai/100 gal (Trt #2); a single low-volume spray application using the SC formulation at 0.25 lb ai/200,000 fruit (Trt #3); a combination of a drench application at 0.25 lb ai/100 gal and a low-volume spray application at 0.25 lb ai/200,000 fruit using the SC formulation (Trt #4); a combination of a drench application at 0.25 lb ai/100 gal and a low-volume spray application at 0.25 lb ai/200,000 fruit using the WP formulation (Trt #5); and a single low-volume spray application using the WP formulation at 0.50 lb ai/200,000 fruit (Trt #6). All the low-volume applications included the use of a finishing wax at the rates recommended on the label for the wax. After the final application, fruits were

allowed to dry, and duplicate treated samples were collected and placed in frozen storage. In addition, selected subsamples of apples and pears from Treatments 2, 4, and 5 were also gently washed prior to sampling.

The HPLC/UV method (Method AG-597B) used to determine fludioxonil residues in/on apples and pears was adequately validated in conjunction with the analysis of treated samples. Concurrent method recoveries from samples fortified at 0.02-2.0 ppm ranged from 70-115% and the overall average was 92 ± 14% (Table C.1). Apparent residues of fludioxonil were <LOQ in/on all apple and pear control samples. The validated method LOQ is 0.02 ppm and the estimated LOD is 0.013 ppm. Adequate sample calculations and example chromatograms were provided.

Pome fruit samples were stored for up to 3.4 months prior to extraction for analysis (Table C.2). Adequate storage stability data are available indicating that fludioxonil is stable at -20 °C for up to 28 months on grapes (D258870, W. Donovan, 12/20/99). These data will support the frozen storage intervals in the current trials.

The distribution of residues between the various post-harvest treatments was similar for apples and pears. For the SC formulation, residues were 0.26-1.60 ppm in/on apples and 0.02-1.20 in/on pears following the single drench application at 0.25 lb ai/100 gal (Trt #2, Table C.3), and residue levels were similar in/on apples (0.06-1.00 ppm) and pears (0.11-1.40 ppm) following a low-volume application at 0.25 lb ai/200,000 fruit (Trt #3). The highest residue levels were observed in/on apples (0.42-2.30 ppm) and pears (0.39-2.90 ppm) following the combined drench and low-volume applications of the SC formulation at a total rate of 0.5 lb ai (Trt #4). Average residues in/on apples were 0.81, 0.33, and 1.04 ppm for Treatments 2, 3 and 4, respectively (Table C.4), and average residues in/on pears were 0.50, 0.63, 1.23 ppm for Treatments 2, 3 and 4.

For the WP formulation, residues were 0.39-0.73 ppm in/on apples and 0.42-0.97 ppm pears following the combined drench and low-volume applications at a total rate of 0.5 lb ai (Trt# 5); and residues were 0.05-051 ppm in/on apples and 0.12-1.60 in/on pears following the single low volume application at 0.5 lb ai/100 gal (Trt #6). Average residues for Treatment 5 and 6 were 0.52 and 0.19 ppm in/on apples and 0.67 and 0.54 ppm in/on pears. Comparing residues from the combined drench and low-volume applications of the SC and WP formulations (Trt #4 and #5) indicates that residues from the WP formulation were slightly lower than from the SC formulation.

Comparing average residues in/on unwashed and washed fruits within each trial indicates that mild washing with water reduced residues by an average of 49%. In 11 trials, washing reduced residues by 5-94%, and in one test residues there was no difference between washed and unwashed fruits.

TABLE C.1. Summary of Concurrent Method Recoveries of Fludioxonil from Pome Fruits.

Analyte	Matrix	Spike level (ppm)	Sample size (n)	Recoveries (%)	Mean ± std dev (%)
Fludioxonil	Apple and Pear	0.02	6	101, 84, 73, 112, 115, 104	98 ± 16
		0.10	2	70, 84	77 [illegible]
		0.20	8	82, 92, 94, 91, 107, 87, 93, 71	90 ± 10
		2.0	2	104, 99	102
		Overall	18	70-115	92 ± 14

TABLE C.2 Summary of Storage Conditions.

Matrix	Storage Temperature (°C)	Actual Storage Duration (months)	Interval of Demonstrated Storage Stability (months)[1]
Apples and pears	-20	1.1-3.4	28

[1] D258870, W. Donovan, 12/20/99.

TABLE C.3 Residue Data from Post-harvest Pome fruit Trials with Fludioxonil (SC or WP).

Trial ID (City, State; Year)	Crop; Variety	Formulation	TRT #	Total Rate (lb ai)[1]	Commodity	PTI[2] (days)	Fludioxonil Residues (ppm)[3]
Visalia, CA 2004 5300	Apple; Golden Delicions	1.9 lb/gal SC	2	0.25	Fruit	0	0.26, 0.38
		1.9 lb/gal SC	3	0.25	Fruit	0	0.09, 0.41
					Washed Fruit	0	<0.02, 0.22
		1.9 lb/gal SC	4	0.50	Fruit	0	1.3, 0.46
					Washed Fruit	0	0.44, 0.47
		50 WP	5	0.50	Fruit	0	0.73, 0.46
					Washed Fruit	0	<0.02, 0.23
		50 WP	6	0.50	Fruit	0	0.51, 0.05
Hudson, NY 2004 5301	Apple, Empire	1.9 lb/gal SC	2	0.25	Fruit	0	1.6, 0.73
		1.9 lb/gal SC	3	0.25	Fruit	0	0.06, 0.07
					Washed Fruit	0	<0.02, 0.02
		1.9 lb/gal SC	4	0.50	Fruit	0	0.58, 0.53
					Washed Fruit	0	0.68, 0.34
		50 WP	5	0.50	Fruit	0	0.39, 0.50
					Washed Fruit	0	0.30, 0.24
		50 WP	6	0.50	Fruit	0	0.10, 0.09
Parlier, CA 2004 5302	Apple, Granny Smith	1.9 lb/gal SC	2	0.25	Fruit	0	1.1, 1.2
		1.9 lb/gal SC	3	0.25	Fruit	0	0.74, 1.0
		1.9 lb/gal SC	4	0.50	Fruit	0	2.3, 2.2
Hudson, NY 2004 5303	Apple, Empire	1.9 lb/gal SC	2	0.25	Fruit	0	0.70, 0.48
		1.9 lb/gal SC	3	0.25	Fruit	0	0.14, 0.14
		1.9 lb/gal SC	4	0.50	Fruit	0	0.42, 0.51
Visalia, CA 2004 5304	Pear, Bosc	1.9 lb/gal SC	2	0.25	Fruit	0	0.52, 0.38
		1.9 lb/gal SC	3	0.25	Fruit	0	0.78, 0.88
					Washed Fruit	0	0.08, 0.19
		1.9 lb/gal SC	4	0.50	Fruit	0	2.2, 1.4
					Washed Fruit	0	0.05, 0.16
		50 WP	5	0.50	Fruit	0	0.97, 0.69
					Washed Fruit	0	0.09, 0.50
		50 WP	6	0.5	Fruit	0	1.6, 0.33
Hudson, NY 2004 5305	Pear, Bosc	1.9 lb/gal SC	2	0.25	Fruit	0	0.36, 0.55
		1.9 lb/gal SC	3	0.25	Fruit	0	0.11, 0.14
					Washed Fruit	0	0.10, 0.05
		1.9 lb/gal SC	4	0.50	Fruit	0	0.62, 0.53
					Washed Fruit	0	0.62, 0.47

TABLE C.3. Residue Data from Post-harvest Pome fruit Trials with Fludioxonil (SC or WP).

Trial ID (City, State; Year)	Crop; Variety	Formulation	TRT #	Total Rate (lb ai)[1]	Commodity	PTI[2] (days)	Fludioxonil Residues (ppm)[3]
		50 WP	5	0.50	Fruit	0	0.61, 0.42
					Washed Fruit	0	0.63, 0.41
		50 WP	6	0.5	Fruit	0	0.12, 0.12
Parlier, Ca 2004 5306	Pear, Bartlett	1.9 lb/gal SC	2	0.25	Fruit	0	0.10, 1.2
		1.9 lb/gal SC	3	0.25	Fruit	0	1.4, 1.3
		1.9 lb/gal SC	4	0.50	Fruit	0	2.9, 0.39
Hudson, NY 2004 5307	Pear, Bosc	1.9 lb/gal SC	2	0.25	Fruit	0	0.86, 0.02
		1.9 lb/gal SC	3	0.25	Fruit	0	0.30, 0.14
		1.9 lb/gal SC	4	0.50	Fruit	0	0.86, 0.95

[1] Rates are expressed in lb ai/100 gallons for the drench applications and in lb ai/200,000 fruit for the low-volume application.
[2] The validated method LOQ is 0.02 ppm.

TABLE C.4. Summary of Residue Data from Post-harvest Pome Fruit Trials with Fludioxonil (SC or WP).

Commodity	Application (Trt#)	PTI (days)	Total Rate (lb ai)[1]	Residue Levels (ppm)[2]						
				n	Min.	Max.	HAFT[3]	Median	Mean	Std. Dev.
Apple	Drench application (#2)	0	0.25	8	0.26	1.60	1.17	0.72	0.81	0.46
	Low-volume application (#3)		0.25	8	0.06	1.00	0.87	0.14	0.33	0.36
	Drench + wash + low-volume application (#4)		0.50	8	0.42	2.30	2.25	0.56	1.04	0.80
	Drench + wash + low-volume application (#5)		0.50	4	0.39	0.73	0.60	0.48	0.52	0.15
	Low-volume application (#6)		0.50	4	0.05	0.51	0.28	0.10	0.19	0.22
Pear	Drench application (#2)	0	0.25	8	0.02	1.20	0.65	0.45	0.50	0.39
	Low-volume application (#3)		0.25	8	0.11	1.40	1.35	0.54	0.63	0.53
	Drench + wash + low-volume application (#4)		0.50	8	0.39	2.90	1.80	0.91	1.23	0.89
	Drench + wash + low-volume application (#5)		0.50	4	0.42	0.97	0.83	0.65	0.67	0.23
	Low-volume application (#6)		0.50	4	0.12	1.60	0.97	0.23	0.54	0.71

[1] Rates are expressed in lb ai/100 gallons for the drench applications and in lb ai/200,000 fruit for the low-volume application.
[2] The LOQ is 0.02 ppm.
[3] HAFT = Highest-Average Field Trial.

D. CONCLUSION

The apple and pear data are adequate and will support the post-harvest use of the 1.9 lb/gal SC formulation of fludioxonil as either a single drench application at up to 0.25 lb ai/100 gal, a low-volume spray application at up to 0.25 lb ai/200,000 fruit, or a combined drench and low-volume spray application on the same day at rates indicated above. The data will also support the post-harvest use of the WP formulation on pome fruit as a combined drench and low-volume spray at a total rate of 0.5 lb ai, or as a low-volume spray at up to 0.5 lb ai/200,000 fruit. In addition, the data support the inclusion of a commercial finishing wax in the treatment solution.

E. REFERENCES

DP #: 258870
Subject: PP# 7E04919. Fludioxonil for use on Grapes. Evaluation of Residue Data and Analytical Methods.
From: W. Donovan
To: M. Waller
Dated: 12/20/99
MRID: 44382322-4438370

F. DOCUMENT TRACKING

RDI: RAB1 Chemists (11/1/06)
Petition Number(s): NA
DP#: 325160
PC Code: 071503

Template Version June 2005

Primary Evaluator — Date: 16-NOV-2006
George F. Kramer, Ph.D., Senior Chemist
Registration Action Branch (RAB1)
Health Effects Division (HED) (7509P)

Approved by — Date: 16-NOV-2006
P.V. Shah, Ph.D., Branch Senior Scientist
RAB1/HED (7509P)

This DER was originally prepared under contract by Dynamac Corporation (1910 Sedwick Rd., Building 100, Durham, NC 27713; submitted 7/31/2006). The DER has been reviewed by HED and revised to reflect current Office of Pesticide Programs (OPP) policies.

STUDY REPORT:

46715504. Ediger K. (2005) Fludioxonil-Magnitude of the Residues in or on Kiwi Fruit Following Post-Harvest Applications. Lab Project Number: T003403-03. Unpublished study prepared by Syngenta Crop Protection. 143 pages.

EXECUTIVE SUMMARY:

Two post-harvest trials were conducted on kiwifruit in CA during 2004. At trial each location, kiwifruit received a single, post-harvest application of fludioxonil, formulated as a 1.9 lb/gal SC or 50% WP. Each trial consisted of three or five different treatments, including a control (Trt #1); a single dip application using the SC formulation at 0.25 lb ai/100 gal (Trt #2); a single low-volume spray application using the SC formulation at 0.25 lb ai/200,000 fruit (Trt #3); and single dip applications using the WP formulation at 0.25 or 0.50 lb ai/100 gal (Trts #4 and #5). Following application, fruits were allowed to dry, and duplicate treated samples were collected from each treatment and placed in frozen storage. Subsamples from Treatments #2 and #5 were also held in refrigerated storage for 30 days prior to sampling, to examine decline during storage. Samples were stored frozen from collection to analysis for up to 2.9 months, an interval supported by available storage stability data.

The high-performance liquid chromatography (HPLC)/ultraviolet (UV) method (Method AG-597B) used to determine fludioxonil residues in/on kiwifruits is the current tolerance enforcement method for plants and was adequately validated in conjunction with the field sample analyses. For this method, residues are extracted with acetonitrile (ACN):water, filtered, concentrated, and partitioned into methyl tert-butyl ethyl (MTBE). Residues are then solvent exchanged into toluene and cleaned up using silica and phenyl solid-phase extraction (SPE) cartridges. Purified residues are then analyzed by HPLC/UV using a normal-phase amino column with a mobile phase of hexane:methanol:isopropyl alcohol. The validated limit of quantitation (LOQ) is 0.02 ppm, and the estimated limit of detection (LOD) was 0.005 ppm.

For the SC formulation, residues in/on kiwifruits were 2.5-5.1 ppm following the dip application at 0.25 lb ai/100 gal and 1.4-4.2 ppm following the low-volume spray application at 0.25 lb ai/200,000 fruit, and residues averaged 3.78 and 3.95 ppm for the two treatments, respectively. For the WP formulation, residues were 0.67-4.2 ppm following the dip application at 0.25 lb

ai/100 gal and 5.5-7.5 ppm following the dip application at 0.5 lb ai/100 gal, and average residues were 2.92 and 6.55 ppm, respectively. Residues from the SC and WP formulations were similar for the dip applications at 0.25 lb ai/100 gal, and refrigerated storage for up to 30 days had no effect on residue levels.

STUDY/WAIVER ACCEPTABILITY/DEFICIENCIES/CLARIFICATIONS:

Under the conditions and parameters used in the study, the post-harvest residue data on kiwifruit are classified as scientifically acceptable. The acceptability of this study for regulatory purposes is addressed in the forthcoming U.S. EPA Residue Chemistry Summary Document [DP# 325160].

COMPLIANCE:

Signed and dated Good Laboratory Practice (GLP), Quality Assurance and Data Confidentiality statements were provided. The study author cited deviations from GLP compliance that included gross sample weight determinations and field history which were not collected according to GLP guidelines, and application solution data were not generated as required in 40 CFR part 160.113(a)(1) and (3). None of these deviations affect the acceptability of the study.

A. BACKGROUND INFORMATION

Fludioxonil is a contact fungicide, which inhibits protein kinase, leading to reduced fungal growth and development. Tolerances are currently established for residues of fludioxonil, 4-(2,2-difluoro-1,3-benzodioxol-4-yl)-1*H*-pyrrole-3-carbonitrile, in/on various plant commodities at levels ranging from 0.01-500 ppm [40 CFR §180.516], including a 20 ppm tolerance on kiwifruit.

TABLE A.1. Fludioxonil Nomenclature.

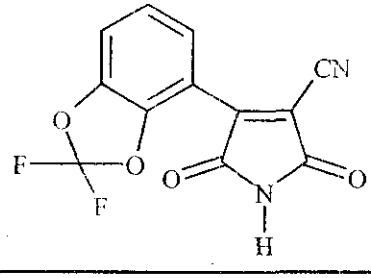
Compound	
Common name	Fludioxonil
Company experimental name	CGA-173506
IUPAC name	4-(2,2-difluoro-1,3-benzodioxol-4-yl)-*1H*-pyrrole-3-carbonitrile
CAS name	4-(2,2-difluoro-1,3-benzodioxol-4-yl)-*1H*-pyrrole-3-carbonitrile
CAS registry number	131341-86-1
End-use products (EP)	Scholar® Fungicide (50% WP; EPA Reg. No. 100-969) Scholar® Fungicide (1.9 lb/gal SC; EPA Reg. No. 100-###)

TABLE A.2. Physicochemical Properties of Fludioxonil.		
Parameter	Value	Reference
Melting point	199.8 °C	Provided in this study
pH	8-9 @ 25 °C (1% aqueous Dispersion)	
Density	1.54 g/cm^3 typical at 23 °C	
Water solubility (25 °C)	1.8 mg/L	
Solvent solubility (mg/L @ 25 °C)	Ethanol 44,000 Acetone 190,000 Toluene 2,700 n-Octanol 20,000 n-Hexane 7.8	
Vapor pressure (25 °C)	2.9 x 10^{-9} mm Hg	
Dissociation constant, pK_a	pK_{a1} <0 pK_{a2} ~ 14.1	
Octanol/water partition coefficient, Log(K_{OW})	4.12 @ 25 °C	
UV/visible absorption spectrum	12,384 l/mol x cm @266 nm (neutral solution) 12,327 l/mol x cm @ 265 nm (acidic solution) 11,790 l/mol x cm @ 271 nm (basic solution)	

B. EXPERIMENTAL DESIGN

B.1. Study Site Information

The untreated kiwifruits used for post-harvest treatments were obtained from commercial or research orchards. As applications were made post-harvest at indoor facilities, variables such as soil type, length of growing season and weather are not relevant to the current study.

Fludioxonil (SC or WP) was applied to kiwifruits post-harvest as either a single dip application or a low-volume spray (Table B.1.1). For the dip application, fruits were placed in a bucket or tray containing the application solution and were gently agitated in solution for approximately one minute. For the low-volume application, fruits were treated by sending them through a packing line equipped with either controlled droplet applicators or PVC rollers with spray nozzles.

TABLE B.1.1. Study Use Pattern on Kiwifruits: Post-harvest Application of Fludioxonil (SC or WP).						
Location (City, State; Year) Trial ID	Post-harvest Application					
	Trt#	Method; Timing	Formulation	Single Rate (lb ai)[1]	Total rate (lb ai)[1]	Additives
Visalia, CA; 2004 5310	2	Single dip application	1.9 lb/gal SC	0.25	0.25	None
	3	Single low-volume application	1.9 lb/gal SC	0.25	0.25	None
	4	Single dip application	50% WP	0.25	0.25	None
	5	Single dip application	50% WP	0.50	0.50	None
Parlier, CA; 2004 5311	2	Single dip application	1.9 lb/gal SC	0.25	0.25	None
	3	Single low-volume application	1.9 lb/gal SC	0.25	0.25	None
	4	Single dip application	50% WP	0.25	0.25	None
	5	Single dip application	50% WP	0.50	0.50	None

[1] Rates are expressed in lb ai/100 gallons for the dip application and in lb ai/200,000 fruit for the low-volume application.

B.2. Sample Handling and Preparation

The fruit was allowed to dry after application, and then duplicate treated samples were collected from each treatment and placed in frozen storage on the day of treatment. Subsamples from Treatments #2 and #5 were also refrigerated (7 ± 8 °C) for 30 days prior to sampling in order to examine residue decline under refrigerated conditions. All samples were shipped frozen to Syngenta Corp Protection, Inc., Greensboro, NC for sample preparation, where samples were stored at -20 °C. For analysis, the prepared samples were later shipped frozen to Enviro-Test Laboratories, Edmonton, Alberta, where samples were stored at <-20 °C.

B.3. Analytical Methodology

Kiwifruit samples were analyzed using HPLC/UV method (Method AG-597B), "Analytical Method for the Determination of CGA-173506 in Crops by High Performance Liquid Chromatography Including Validation Data." This method is the current tolerance enforcement method for determining fludioxonil in plant commodities.

For this method, residues are extracted with ACN:water (90:10, v/v), filtered, and concentrated to remove the ACN. Residues were diluted with a saturated salt solution and partitioned into MTBE. Residues were then solvent exchanged into toluene, diluted with hexane, and cleaned up using a silica SPE cartridge eluted with toluene:dichloromethane (1:1, v/v). Residues were next concentrated to dryness, reconstituted in methanol:water, and further purified using a phenyl SPE cartridge eluted with acetone. Purified residues were concentrated, reconstituted in the HPLC mobile phase, hexane:methanol:isopropyl alcohol (90:6:6, v/v/v), and analyzed by HPLC/UV at 268 nm using a normal phase amino column and external standards. The LOQ is 0.02 ppm, and the estimated LOD was 0.005 ppm.

In conjunction with the analysis of field trial samples, the above method was validated using control samples of kiwifruit fortified with fludioxonil at 0.02-10.0 ppm.

C. RESULTS AND DISCUSSION

The number of kiwifruit post-harvest trials is adequate, and geographic representation of the trial data is not relevant as the proposed use is for post-harvest application in fruit packing houses. Two post-harvest trials were conducted in which kiwifruit received a single post-harvest application of fludioxonil, formulated as a 1.9 lb/gal SC or 50% WP. Each trial consisted of three or five different treatments, including a control (Trt #1); a single dip application using the SC formulation at 0.25 lb ai/100 gal (Trt #2); a low-volume spray application using the SC formulation at 0.25 lb ai/200,000 fruit (Trt #3); and single dip applications using the WP formulation at 0.25 or 0.50 lb ai/100 gal (Trts #4 and #5). The fruit were allowed to dry following application, and duplicate treated samples were collected from each treatment and placed in frozen storage. In addition, subsamples from Trt #2 and #5 were held in refrigerated storage for 30 days prior to sampling.

The HPLC/UV method (Method AG-597B) used to determine fludioxonil residues in/on kiwifruit was adequately validated in conjunction with the field sample analyses. Concurrent method recoveries from samples fortified at 0.02-10.0 ppm ranged from 72-119% and the overall average was 99 ± 19% (Table C.1). Apparent residues of fludioxonil were <LOQ in/on one control samples and 0.03 ppm in the remaining 3 control samples. The validated method LOQ is 0.02 ppm, and the estimated LOD was 0.005 ppm. Adequate sample calculations and example chromatograms were provided.

Kiwi samples were stored for up to 2.9 months prior to extraction for analysis (Table C.2.). Adequate storage stability data are available indicating that fludioxonil is stable at -18 °C for up to 28 months on grapes (D258870, W. Donovan, 12/20/99). These data will support the frozen storage intervals in the current trials.

For the SC formulation, residues were 2.5-5.1 ppm following the dip application at the 0.25 lb ai/100 gal rate and 1.4-4.2 ppm following the low-volume spray application at 0.25 lb ai/200,000 fruit (Table C.3), and average residues were similar for the two treatments at 3.78 and 3.95 ppm, respectively (Table C.4). For the WP formulation, residues in/on kiwifruit were 0.67-4.2 ppm following the dip application at 0.25 lb ai/100 gal and 5.5-7.5 ppm following the dip application at 0.5 lb ai/100 gal, and average residues were 2.92 and 6.55 ppm, respectively. Residues from the SC and WP formulations were similar for the dip applications at 0.25 lb ai/100 gal, and refrigerated storage for up to 30 days had no effect on residue levels.

TABLE C.1. Summary of Concurrent Method Recoveries of Fludioxonil from Kiwifruits.

Analyte	Matrix	Spike level (ppm)	Sample size (n)	Recoveries (%)	Mean ± std dev (%)
Fludioxonil	Kiwifruit	0.02	1	113	NA
		0.10	2	119, 72	96
		10.0	2	90, 103	97
		Overall	5	72-119	99 ± 19

TABLE C.2 Summary of Storage Conditions.

Matrix	Storage Temperature (°C)	Actual Storage Duration (months)	Interval of Demonstrated Storage Stability (months)[1]
Kiwifruit	-20	0.8-2.9	28

[1] D258870, W. Donovan, 12/20/99.

TABLE C.3. Residue Data from Post-harvest Kiwifruit Trials with Fludioxonil (SC or WP).

Trial ID (City, State; Year)	Variety	Formulation	Treatment type (#)	Total Rate (lb ai)[1]	Commodity	PTI[2] (days)	Fludioxonil Residues (ppm)[3]
Visalia, CA; 2004 5310	Hayward	1.9 lb/gal SC	Single dip application (#2)	0.25	Fruit	0	5.1, 4.9
						30	4.5, 4.2
		1.9 lb/gal SC	Single low-volume application (#3)	0.25	Fruit	0	1.4, 2.0
		50% WP	Single dip application (#4)	0.25	Fruit	0	4.2, 0.67
		50% WP	Single dip application (#5)	0.50	Fruit	0	7.5, 6.8
						30	5.4, 8.0
Parlier, CA; 2004 5311	Hayward	1.9 lb/gal SC	Single dip application (#2)	0.25	Fruit	0	2.5, 2.6
						30	3.6, 3.5

TABLE C.3. Residue Data from Post-harvest Kiwifruit Trials with Fludioxonil (SC or WP).

Trial ID (City, State; Year)	Variety	Formulation	Treatment type (#)	Total Rate (lb ai)[1]	Commodity	PTI[2] (days)	Fludioxonil Residues (ppm)[3]
		1.9 lb/gal SC	Single low-volume application (#3)	0.25	Fruit	0	2.8, 4.2
		50% WP	Single dip application (#4)	0.25	Fruit	0	3.4, 3.4
		50% WP	Single dip application (#5)	0.50	Fruit	0	6.4, 5.5
						30	3.7, 6.6

1 Rates are expressed in lb ai/100 gallons for the dip application and in lb ai/200,000 fruit for the low-volume application.
2 Post-treatment interval; selected samples were refrigerated (7 °C) for 30 days prior to sampling.
3 The validated method LOQ is 0.02 ppm.

TABLE C.4. Summary of Residue Data from Post-harvest Kiwifruit Trials with Fludioxonil (SC or WP).

Commodity	Treatment (formulation)	Total Rate (lb ai)[1]	PTI[2] (days)	Residue Levels (ppm)[3]						
				n	Min.	Max.	HAFT[4]	Median	Mean	Std. Dev.
Whole fruit	Dip application (1.9 lb/gal SC)	0.25	0	4	2.50	5.10	5.00	3.75	3.78	1.42
			30	4	3.50	4.50	4.35	3.90	3.95	0.48
	Low-volume application (1.9 lb/gal SC)	0.25	0	4	1.40	4.20	3.50	2.40	2.60	1.21
	Dip application (50% WP)	0.25	0	4	0.67	4.20	3.40	3.40	2.92	1.55
	Dip application (50% WP)	0.50	0	4	5.50	7.50	7.15	6.60	6.55	0.83
			30	4	3.70	8.00	6.70	6.00	5.93	1.82

1 Rates are expressed in lb ai/100 gallons for the dip application and in lb ai/200,000 fruit for the low-volume application.
2 Post-treatment interval; selected samples were refrigerated (7 °C) for 30 days prior to sampling.
3 The method LOQ is 0.02 ppm.
4 HAFT = Highest-Average Field Trial.

D. CONCLUSION

The kiwifruit post-harvest trial data are adequate and will support the post-harvest use of the 1.9 lb/gal SC formulation as a single dip application at up to 0.25 lb ai/100 gal or a low-volume spray application at 0.25 lb ai/200,000 fruit, and the use of the WP formulation as a single dip application at up to 0.5 lb ai/100 gal. For the SC formulation, residues in/on kiwifruits were 2.5-5.1 ppm following the dip application at 0.25 lb ai/100 gal and 1.4-4.2 ppm following the low-volume spray application at 0.25 lb ai/200,000 fruit, and residues averaged 3.78 and 3.95 ppm for the two treatments, respectively. For the WP formulation, residues were 0.67-4.2 ppm following the dip application at 0.25 lb ai/100 gal and 5.5-7.5 ppm following the dip application at 0.5 lb ai/100 gal, and average residues were 2.92 and 6.55 ppm, respectively.

E. REFERENCES

DP#: 258870
Subject: PP# 7E04919. Fludioxonil for use on Grapes. Evaluation of Residue Data and Analytical Methods.
From: W. Donovan
To: M. Waller
Dated: 12/20/99
MRID: 44382322-4438370

F. DOCUMENT TRACKING

RDI: RAB1 Chemists (11/15/06)
Petition Number(s): NA
DP#: 325160
PC Code: 071503

Template Version June 2005

Primary Evaluator — Date: 16-NOV-2006
George F. Kramer, Ph.D., Senior Chemist
Registration Action Branch (RAB1)
Health Effects Division (HED) (7509P)

Approved by — Date: 16-NOV-2006
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This DER was originally prepared under contract by Dynamac Corporation (1910 Sedwick Rd., Building 100, Durham, NC 27713; submitted 7/31/2006). The DER has been reviewed by HED and revised to reflect current Office of Pesticide Programs (OPP) policies.

STUDY REPORT:

46715505. Ediger K. (2005) Fludioxonil-Magnitude of the Residues in or on Peach and Plum Following Post-Harvest Applications. Lab Project Number: T002780-03. Unpublished study prepared by Syngenta Crop Protection. 196 pages.

EXECUTIVE SUMMARY:

A total of eight post-harvest trials using peaches and plums (4 trials each) were conducted in CA and NY during 2004. At each trial location, peaches or plums received a single, post-harvest application of fludioxonil, formulated as a 1.9 lb/gal suspension concentrate (SC) or a 50% wettable powder (WP). Each trial consisted of three or five different treatments, including a control (Trt #1); a dip application using the SC formulation at 0.25 lb ai/100 gal (Trt #2); a low-volume spray application using the SC formulation at 0.25 lb ai/200,000 fruit (Trt #3); and a low-volume application using the WP formulation at 0.25 or 0.50 lb ai/200,000 fruit (Trts #4 and #5). All treatments included the use of a finishing wax (Decco PNP Lustr251) at rates of 5-33% of the treatment solution or 16.7 gal wax/200,000 fruit. After treatment, fruits were allowed to dry, and duplicate treated samples were collected from each treatment and placed in frozen storage. Subsamples of peaches and plums from Trts #3 and #5 of were also gently washed prior to sampling, and plum subsamples from Trts #3 and #5 from two sites were refrigerated for 5-25 days prior to sampling. Samples were stored frozen from collection to analysis for up to 4.5 months, an interval supported by available storage stability data.

The high-performance liquid chromatography (HPLC)/ultraviolet (UV) method (Method AG-597B) used to determine fludioxonil residues in/on peaches and plums is the current tolerance enforcement method for plants and was adequately validated in conjunction with the analysis of treated samples. For this method, residues are extracted with acetonitrile (ACN):water, filtered, concentrated, and partitioned into methyl tert-butyl ethyl (MTBE). Residues are then solvent exchanged into toluene and cleaned up using silica and phenyl solid-phase extraction (SPE) cartridges. Purified residues are then analyzed by HPLC/UV using a normal-phase amino column with a mobile phase of hexane:methanol:isopropyl alcohol. The validated limit of quantitation (LOQ) is 0.02 ppm, and the limit of detection (LOD) was estimated to be ~0.01 ppm.

In the peach trials, residues in/on fruits sampled immediately after treatment were 1.8-5.0 ppm for the dip application of the SC at 0.25 lb ai/100 gal (Trt #2); 0.77-2.90 ppm for the low-volume application of the SC at 0.25 lb ai/200,000 fruit (Trt #3); 1.4-3.9 ppm for the low-volume application of the WP at 0.25 lb ai/200,000 fruit (Trt #4); and 2.3-5.5 ppm for the low-volume application of the WP at 0.50 lb ai/200,000 fruit (Trt #5). Average residues in/on peaches from Treatments 2 through 5 were 3.0, 1.5, 2.3, and 4.2 ppm, respectively.

In the plum trials, residues in/on fruits sampled immediately after treatment were 0.27-0.46 ppm for the dip application of the SC at 0.25 lb ai/100 gal (Trt #2); 0.13-0.66 ppm for the low-volume application of the SC at 0.25 lb ai/200,000 fruit (Trt #3); 0.19-0.71 ppm for the low-volume application of the WP at 0.25 lb ai/200,000 fruit (Trt #4); and <0.02-1.30 ppm for the low-volume application of the WP at 0.50 lb ai/200,000 fruit (Trt #5). Average residues in/on plums from Treatments 2 through 5 were 0.36, 0.32, 0.38, 0.75 ppm, respectively.

For the SC formulation, the dip application had higher residues in/on peaches than the low-volume spray application at a comparable rate; however for plums, there was no difference in residues between Treatments #2 and #3. Comparing the low-volume application of the two formulations at the 0.25 lb ai rate (Trts #3 and #4), the WP formulation had slightly higher residues in/on peaches than the SC formulation; however, there was no difference in residue levels in/on plums between the two formulations. In both peaches and plums, the highest residues were observed in/on fruit following application of the WP at the higher 0.5 lb ai/200,000 fruit rate.

Washing treated fruits with water reduced residues by an average of 24%, but refrigerated storage up to 25 days had no effect on residue levels.

STUDY/WAIVER ACCEPTABILITY/DEFICIENCIES/CLARIFICATIONS:

Under the conditions and parameters used in the study, the stone fruit field trial residue data are classified as scientifically acceptable. The acceptability of this study for regulatory purposes is addressed in the forthcoming U.S. EPA Residue Chemistry Summary Document [DP# 325160].

COMPLIANCE:

Signed and dated Good Laboratory Practice (GLP), Quality Assurance and Data Confidentiality statements were provided. The study author cited deviations from GLP compliance that included gross sample weight determinations and field history which were not collected according to GLP guidelines, and application solution data were not generated as required in 40 CFR part 160.113(a)(1) and (3). None of these deviations affect the acceptability of the study.

A. BACKGROUND INFORMATION

Fludioxonil is a contact fungicide, which inhibits protein kinase, leading to reduced fungal growth and development. Tolerances are currently established for residues of fludioxonil, 4-(2,2-difluoro-1,3-benzodioxol-4-yl)-1*H*-pyrrole-3-carbonitrile, in/on various plant commodities at levels ranging from 0.01-500 ppm [40 CFR §180.516], including a 5.0 ppm tolerance for the stone fruit crop group.

TABLE A.1. Fludioxonil Nomenclature.

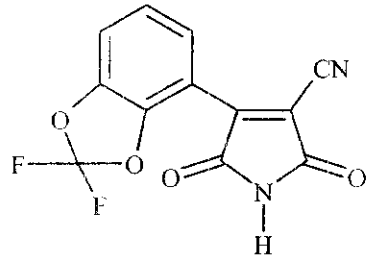
Compound	
Common name	Fludioxonil
Company experimental name	CGA-173506
IUPAC name	4-(2,2-difluoro-1,3-benzodioxol-4-yl)-*1H*-pyrrole-3-carbonitrile
CAS name	4-(2,2-difluoro-1,3-benzodioxol-4-yl)-*1H*-pyrrole-3-carbonitrile
CAS registry number	131341-86-1
End-use products (EP)	Scholar® Fungicide (50% WP; EPA Reg. No. 100-969) Scholar® Fungicide (1.9 lb/gal SC; EPA Reg. No. 100-###)

TABLE A.2. Physicochemical Properties of Fludioxonil.

Parameter	Value	Reference
Melting point	199.8 °C	Provided in this study
pH	8-9 @ 25 °C (1% aqueous Dispersion)	
Density	1.54 g/cm^3 typical at 23 °C	
Water solubility (25 °C)	1.8 mg/L	
Solvent solubility (mg/L @ 25 °C)	Ethanol 44,000 Acetone 190,000 Toluene 2,700 n-Octanol 20,000 n-Hexane 7.8	
Vapor pressure (25 °C)	2.9 x 10^{-9} mm Hg	
Dissociation constant, pK_a	pK_{a1} <0 pK_{a2} ~ 14.1	
Octanol/water partition coefficient, Log(K_{OW})	4.12 @ 25 °C	
UV/visible absorption spectrum	12,384 l/mol x cm @266 nm (neutral solution) 12,327 l/mol x cm @ 265 nm (acidic solution) 11,790 l/mol x cm @ 271 nm (basic solution)	

B. EXPERIMENTAL DESIGN

B.1. Study Site Information

The untreated peaches and plums used for post-harvest treatments were obtained from commercial or research orchards. As applications were made post-harvest at indoor facilities,

variables such as soil type, length of growing season and weather are not relevant to the current study.

Fludioxonil (SC or WP) was applied to peaches and plums as either a single dip application or a low-volume spray (Table B.1.1). For the dip application, fruits were placed in a bucket containing the application solution and were gently agitated in solution for approximately one minute. For the low-volume application, fruits were treated by sending them through a packing line equipped with controlled-droplet applicators (CDAs), brushes, belts, rollers, wig-wag or dribble applicators.

TABLE B.1.1. Study Use Pattern on Stone Fruits: Post-harvest Application of Fludioxonil (SC or WP).

Location (City, State; Year; Trial ID	Post-harvest Application					
	Trt#	Method; Timing	Formulation	Single Rate (lb ai)[1]	Total rate (lb ai)[1]	Additives[2]
Peach Trials						
Hudson, NY; 2004 5285	2	Dip application	1.9 lb/gal SC	0.25	0.25	Wax
	3	Low-volume application	1.9 lb/gal SC	0.25	0.25	Wax
	4	Low-volume application	50% WP	0.25	0.25	Wax
	5	Low-volume application	50% WP	0.5	0.5	Wax
Visalia, CA; 2004 5286	2	Dip application	1.9 lb/gal SC	0.25	0.25	Wax
	3	Low-volume application	1.9 lb/gal SC	0.25	0.25	Wax
	4	Low-volume application	50% WP	0.25	0.25	Wax
	5	Low-volume application	50% WP	0.5	0.5	Wax
Parlier, CA; 2004 5287	2	Dip application	1.9 lb/gal SC	0.25	0.25	Wax
	3	Low-volume application	1.9 lb/gal SC	0.25	0.25	Wax
Hudson, NY; 2004 5288	2	Dip application	1.9 lb/gal SC	0.25	0.25	Wax
	3	Low-volume application	1.9 lb/gal SC	0.25	0.25	Wax
Plums Trials						
Hudson, NY;2004 5289	2	Dip application	1.9 lb/gal SC	0.25	0.25	Wax
	3	Low-volume application	1.9 lb/gal SC	0.25	0.25	Wax
	4	Low-volume application	50% WP	0.25	0.25	Wax
	5	Low-volume application	50% WP	0.5	0.5	Wax
Hudson, NY; 2004 5290	2	Dip application	1.9 lb/gal SC	0.25	0.25	Wax
	3	Low-volume application	1.9 lb/gal SC	0.25	0.25	Wax
Visalia, CA; 2004 5291	2	Dip application	1.9 lb/gal SC	0.25	0.25	Wax
	3	Low-volume application	1.9 lb/gal SC	0.25	0.25	Wax
	4	Low-volume application	50% WP	0.25	0.25	Wax
	5	Low-volume application	50% WP	0.5	0.5	Wax
Parlier, CA; 2004 5292	2	Dip application	1.9 lb/gal SC	0.25	0.25	Wax
	3	Low-volume application	1.9 lb/gal SC	0.25	0.25	Wax

[1] Rates are expressed in lb ai/100 gallons for the dip application and in lb ai/200,000 fruit for the low-volume application.
[2] All applications included the use of a finishing wax (Decco PNP Lustr 251).

B.2. Sample Handling and Preparation

Fruits were allowed to dry after application, and then duplicate treated samples were collected from each treatment and placed in frozen storage on the day of treatment. After collection, selected peach and plum subsamples from Treatments #3 and #5 at four trial sites were also washed by gently rubbing the fruit by hand under running water for ~10 seconds. In addition, plum samples from Treatments #3 and #5 from two sites were refrigerated (7 ± 8 °C) for 5, 15, and ~25 days prior to sampling in order to examine residue decline under refrigerated conditions. All samples were shipped frozen to Syngenta Corp Protection, Inc., Greensboro, NC for sample preparation, where samples were stored at -20 °C. For analysis, the prepared samples were later

shipped frozen to EN-CAS Laboratories, Winston-Salem, NC, where samples were stored at -20 °C.

B.3. Analytical Methodology

Peach and plum samples were analyzed using HPLC/UV method (Method AG-597B), "Analytical Method for the Determination of CGA-173506 in Crops by High Performance Liquid Chromatography Including Validation Data." This method is the current tolerance enforcement method for determining fludioxonil in plant commodities.

For this method, residues are extracted with ACN:water (90:10, v/v), filtered, and concentrated to remove the ACN. Residues were diluted with a saturated salt solution and partitioned into MTBE. Residues were then solvent exchanged into toluene, diluted with hexane, and cleaned up using a silica SPE cartridge eluted with toluene:dichloromethane (1:1, v/v). Residues were next concentrated to dryness, reconstituted in methanol:water, and further purified using a phenyl SPE cartridge eluted with acetone. Purified residues were concentrated, reconstituted in the HPLC mobile phase, hexane:methanol:isopropyl alcohol (90:6:6, v/v/v), and analyzed by HPLC/UV at 268 nm using a normal phase amino column and external standards. The LOQ is 0.02 ppm, and the LOD was defined as the lowest standard injected (1 ng), which is equivalent to ~0.01 ppm based on peak areas.

In conjunction with the analysis of field trial samples, the above method was validated using control samples of peach and plums fortified with fludioxonil at 0.02-10.0 ppm.

C. RESULTS AND DISCUSSION

The number of peach and plum post-harvest trials is adequate, and geographic representation of the residue data is not relevant as the proposed use is for post-harvest application in fruit packing houses. A total of eight post-harvest trials were conducted in which peach or plums (4 trials each) received a single post-harvest application of fludioxonil, formulated as a 1.9 lb/gal SC or 50% WP. Each trial consisted of three or five different treatments, including a control (Trt #1); a single dip application using the SC formulation at 0.25 lb ai/100 gal (Trt #2); a single low-volume spray application using the SC formulation at 0.25 lb ai/200,000 fruit (Trt #3); and single low-volume applications using the WP formulation at 0.25 or 0.50 lb ai/200,000 fruit (Trts #4 and #5). All treatments included the use of a finishing wax (Decco PNP Lustr251) at reported rates of 5-33% of the treatment solution or 16.7 gal wax/200,000 fruit. After treatment, fruits were allowed to dry, and duplicate treated samples were collected and placed in frozen storage. Subsamples of peaches and plums from Trts #3 and #5 of selected trials were also gently washed prior to sampling. In addition, plum samples from Trts #3 and #5 from two sites were refrigerated for 5-25 days prior to sampling.

The HPLC/UV method (Method AG-597B) used to determine fludioxonil residues in/on peaches and plums was adequately validated in conjunction with the analysis of treated samples. Concurrent method recoveries from samples fortified at 0.02-10.0 ppm ranged from 69-111% and the overall average was 89 ± 9% (Table C.1). Apparent residues of fludioxonil were <LOQ

in/on 26 control samples and 0.05 ppm in/on one peach control sample. The validated method LOQ is 0.02 ppm and the estimated LOD is ~0.01 ppm. Adequate sample calculations and example chromatograms were provided.

Peach and plum samples were stored frozen for up to 4.5 months prior to extraction for analysis (Table C.2). Adequate storage stability data are available indicating that fludioxonil is stable at -20 °C for at least 2-4 months in cherries, peaches and plums (D258861, W. Donovan, 11/29/99) and for at least to 28 months on grapes (D258870, W. Donovan, 12/20/99). These data will support the frozen storage intervals in the current trials.

In the peach trials, residues in/on fruits sampled immediately after treatment were 1.8-5.0 ppm for the dip application of the SC at 0.25 lb ai/100 gal (Trt #2, Table C.3); 0.77-2.90 ppm for the low-volume application of the SC at 0.25 lb ai/200,000 fruit (Trt #3); 1.4-3.9 ppm for the low-volume application of the WP at 0.25 lb ai/200,000 fruit (Trt #4); and 2.3-5.5 ppm for the low-volume application of the WP at 0.50 lb ai/200,000 fruit (Trt #5). Average residues in/on peaches from Treatments 2 through 5 were 3.0, 1.5, 2.3, and 4.2 ppm, respectively (Table C.4.1). In the plum trials, residues in/on fruits sampled immediately after treatment were 0.27-0.46 ppm for the dip application of the SC at 0.25 lb ai/100 gal (Trt #2); 0.13-0.66 ppm for the low-volume application of the SC at 0.25 lb ai/200,000 fruit (Trt #3); 0.19-0.71 ppm for the low-volume application of the WP at 0.25 lb ai/200,000 fruit (Trt #4); and <0.02-1.30 ppm for the low-volume application of the WP at 0.50 lb ai/200,000 fruit (Trt #5). Average residues in/on plums from Treatments 2 through 5 were 0.36, 0.32, 0.38, 0.75 ppm, respectively.

For the SC formulation, the dip application had higher residues in/on peaches than the low-volume spray application at a comparable rate; however for plums, there was no difference in residues between Treatments #2 and #3. Comparing the low-volume application of the two formulations at the 0.25 lb ai rate (Trts #3 and #4), the WP formulation had slightly higher residues in/on peaches than the SC formulation; however, there was no difference in residue levels in/on plums between the two formulations. In both peaches and plums, the highest residues were observed in/on fruit following application of the WP at the higher 0.5 lb ai/200,000 fruit rate.

Comparing average residues in/on unwashed and washed fruits within each trial indicates that mild washing with water reduced residues by an average of 24%. In ten trials, washing reduced residues by 13-68%, and in two trials residues were actually higher (108-122%) on the washed fruits.

Refrigerated storage of treated fruit for up to ~25 days had no effect on residue levels (Table C.4.2).

TABLE C.1. Summary of Method Recoveries of Fludioxonil from Stone Fruits.

Analyte	Matrix	Spike level (ppm)	Sample size (n)	Recoveries (%)	Mean ± std dev (%)[1]
Fludioxonil	Stone Fruit	0.02	1	92	NA
		0.20	11	91, 94, 94, 84, 98, 99, 92, 88, 111, 75, 94	93 ± 9
		0.50	2	93, 89	91
		1.0	6	91, 82, 83, 82, 88, 69	83 ± 8
		2.0	3	80, 97, 81	86
		5.0	4	78, 95, 89, 97	90 ± 9
		10.0	1	80	NA
		Overall	28	69-111	89 ± 9

[1] Standard deviations were only calculated for fortifications with >3 samples.

TABLE C.2. Summary of Storage Conditions.

Matrix	Storage Temperature (°C)	Actual Storage Duration (months)	Interval of Demonstrated Storage Stability (months)[1]
Peaches and Plums	-20	1.5-4.5	28

[1] D258861, W. Donovan, 11/29/99; and D258870, W. Donovan, 12/20/99.

TABLE C.3 Residue Data from Stone Field Trials with Fludioxonil (SC or WP).

Trial ID (City, State; Year)	Crop; Variety	Formulation	Trt #	Total Rate (lb ai)[1]	Commodity	PTI[2] (days)	Fludioxonil Residues (ppm)[3]
Hudson, NY; 2004 5285	Peach, Johnboy	1.9 lb/gal SC	2	0.25	Fruit	0	3.7, 2.5
		1.9 lb/gal SC	3	0.25	Fruit	0	0.83, 1.9
					Washed Fruit	0	1.2, 0.68
		50% WP	4	0.25	Fruit	0	1.4, 3.9
		50% WP	5	0.5	Fruit	0	5.5, 2.3
					Washed Fruit	0	1.2, 4.1
Visalia, CA; 2004 5286	Peach, Elegant Lady	1.9 lb/gal SC	2	0.25	Fruit	0	2.5, 2.1
		1.9 lb/gal SC	3	0.25	Fruit	0	2.6, 2.9
					Washed Fruit	0	3.5, 3.2
		50% WP	4	0.25	Fruit	0	1.6, 2.2
		50% WP	5	0.5	Fruit	0	4.4, 4.5
					Washed Fruit	0	4.3, 2.7
Parlier, CA; 2004 5287	Peach, Elegant Lady	1.9 lb/gal SC	2	0.25	Fruit	0	5.0, 4.6
		1.9 lb/gal SC	3	0.25	Fruit	0	0.99, 1.0
Hudson, NY; 2004 5288	Peach, Johnboy	1.9 lb/gal SC	2	0.25	Fruit	0	1.8, 1.8
		1.9 lb/gal SC	3	0.25	Fruit	0	0.77, 1.0
Hudson, NY; 2004 5289	Plum, Casselmann	1.9 lb/gal SC	2	0.25	Fruit	0	0.39, 0.33
		1.9 lb/gal SC	3	0.25	Fruit	0	0.13, 0.18
						5	0.11, 0.11
						15	0.27, 0.12
						25	0.17, 0.14
					Washed Fruit	0	0.06, 0.04
						15	0.12, 0.14
		50% WP	4	0.25	Fruit	0	0.19, 0.19
		50% WP	5	0.5	Fruit	0	<0.02, 0.40
						5	0.32, 0.31
						15	0.12, 0.36
						25	0.24, 0.38
					Washed Fruit	0	0.08, 0.12
						15	0.20, 0.20

TABLE C.3. Residue Data from Stone Field Trials with Fludioxonil (SC or WP).

Trial ID (City, State; Year)	Crop; Variety	Formulation	Trt #	Total Rate (lb ai)[1]	Commodity	PTI[2] (days)	Fludioxonil Residues (ppm)[3]
Hudson, NY; 2004 5290	Plum, Castleton	1.9 lb/gal SC	2	0.25	Fruit	0	0.46, 0.28
		1.9 lb/gal SC	3	0.25	Fruit	0	0.25, 0.20
Visalia, CA; 2004 5291	Plum, Royal Diamond	1.9 lb/gal SC	2	0.25	Fruit	0	0.27, 0.37
		1.9 lb/gal SC	3	0.25	Fruit	0	0.66, 0.43
						5	0.52, 0.44
						15	0.92, 0.81
						26	0.77, 0.55
					Washed Fruit	0	0.46, 0.49
						15	0.49, 0.67
		50% WP	4	0.25	Fruit	0	0.71, 0.42
		50% WP	5	0.5	Fruit	0	1.3, 1.3
						5	1.9, 1.6
						15	1.7, 1.2
						26	1.5, 1.1
					Washed Fruit	0	1.7, 1.1
						15	0.96, 1.3
Parlier, CA; 2004 5292	Plum, Casselmann	1.9 lb/gal SC	2	0.25	Fruit	0	0.35, 0.39
		1.9 lb/gal SC	3	0.25	Fruit	0	0.36, 0.36

[1] Rates are expressed in lb ai/100 gallons for the dip application and in lb ai/200,000 fruit for the low-volume application.
[2] PTI= post-treatment interval; selected samples were refrigerated for 5-26 days prior to sampling.
[3] The validated method LOQ is 0.02 ppm.

TABLE C.4.1. Summary of Residue Data from Post-harvest Stone Fruit Trials with Fludioxonil (SC or WP).

Commodity	Formulation; Trt#	PTI (days)	Total Rate (lb ai)[1]	Residue Levels (ppm)[2]						
				n	Min.	Max.	HAFT[3]	Median	Mean	Std. Dev.
Peach	SC; Dip (#2)	0	0.25	8	1.80	5.00	4.80	2.50	3.00	1.27
	SC; Low-volume (#3)		0.25	8	0.77	2.90	2.75	1.00	1.50	0.85
	WP; Low-volume (#4)		0.25	4	1.40	3.90	2.65	1.90	2.28	1.14
	WP; Low-volume (#5)		0.50	4	2.30	5.50	4.45	4.45	4.18	1.35
Plum	SC; Dip (#2)	0	0.25	8	0.27	0.46	0.37	0.36	0.36	0.06
	SC; Low-volume (#3)		0.25	8	0.13	0.66	0.55	0.31	0.32	0.17
	WP; Low-volume (#4)		0.25	4	0.19	0.71	0.57	0.31	0.38	0.25
	WP; Low-volume (#5)		0.50	4	<0.02	1.30	1.30	0.85	0.75	0.65

[1] Rates are expressed in lb ai/100 gallons for the dip application and in lb ai/200,000 fruit for the low-volume application.
[2] The method LOQ is 0.02 ppm. For calculation of the median, mean and standard deviation, ½LOQ (0.01 ppm) was used for samples with residues <LOQ.
[3] HAFT = Highest-Average Field Trial.

TABLE C.4.2. Summary of Residue Decline Data from Plums Held in Refrigerated Storage (7 °C) after Treatment with Fludioxonil (SC or WP).

Commodity	Formulation; Trt#	Total Rate (lb ai)[1]	PTI (days)	Residue Levels (ppm)[1]						
				n	Min.	Max.	HAFT[2]	Median	Mean	Std. Dev.
Plum	Single low-volume application (Trt #3)	0.25	0	4	0.13	0.66	0.55	0.31	0.35	0.24
			5	4	0.11	0.52	0.48	0.28	0.30	0.22
			15	4	0.12	0.92	0.87	0.54	0.53	0.39
			25-26	4	0.14	0.77	0.66	0.36	0.41	0.31
Plum	Single low-volume application (Trt #5)	0.50	0	4	0.01	1.30	1.30	0.85	0.75	0.65
			5	4	0.31	1.90	1.75	0.96	1.03	0.84
			15	4	0.12	1.70	1.45	0.78	0.85	0.73
			25-26	4	0.24	1.50	1.30	0.74	0.81	0.60

[1] Rates are expressed in lb ai/200,000 fruit for the low-volume application.
[2] PTI = post-treatment interval.
[3] The method LOQ is 0.02 ppm.

[4] HAFT = Highest-Average Field Trial.

D. CONCLUSION

The peach and plum data are adequate and will support the post-harvest use of the 1.9 lb/gal SC formulation as either a dip application at up to 0.25 lb ai/100 gal or a low-volume spray application at up to 0.25 lb ai/200,000 fruit. These data will also support the post-harvest use of the WP formulation on peaches and plums as a low-volume spray at up to 0.5 lb ai/200,000 fruit. In addition, these data support the inclusion of a commercial finishing wax in the treatment solution. Average residues in/on peaches from Treatments 2 through 5 were 3.0, 1.5, 2.3, and 4.2 ppm, respectively. Average residues in/on plums from Treatments 2 through 5 were 0.36, 0.32, 0.38, 0.75 ppm, respectively.

E. REFERENCES

DP#: 258861
Subject: PP# 9E06049. Fludioxonil for use on Stone Fruits. Evaluation of Residue Data and Analytical Methods.
From: W. Donovan
To: R. Forrest and S. Brothers
Dated: 11/29/99
MRID: 44893301-44893304

DP#: 258870
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From: W. Donovan
To: M. Waller
Dated: 12/20/99
MRID: 44382322-4438370

F. DOCUMENT TRACKING

RDI: RAB1 Chemists (11/15/06)
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	071503
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Memo Date:	**11/16/2006**
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